CONSOLIDATED INCINERATION FACILITY OPERATOR TRAINING PROGRAM DISTRIBUTED CONTROL SYSTEM (DCS) (U)

Student Study Guide

Approved By:________________________ __________
SWMD Training and Procedures Manager
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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
03	All	Revised objectives. Incorporated DCF information since last revision. Upgraded level of detail.
04	See Change Bars	Revised material to reflect components added to the system. Add clarification per SME recommendations.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

REFERENCES

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2. 261-ARP-FDAS6500TA, *HIGH TEMP PLC CAB* #1, Rev. 01
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4. 261-ARP-MLC14-ALARM, MLC14 LOSS COMM STATUS, Rev. 01
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8. J-JQ-H-1429, *H Area Consolidated Incinerator Facility, Facility Programmable Logic Controller Ladder Logic Diagrams,* Rev. 00
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10. ZIOISX15, *DCS & PLCs System Design Description*, Rev. 00

LIST OF FIGURES

LIST OF TABLES

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

TO 1.00 Without references, **EXPLAIN** the significance of the CIF Distributed Control System to Consolidated Incineration Facility operations, including the impact on operations for a failure of the system.

ENABLING OBJECTIVES

EO 1.01 **STATE** the purpose of the CIF Distributed Control System.

EO 1.02 Briefly **DESCRIBE** how the CIF Distributed Control System accomplishes its intended purpose.

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

TO 2.00 **DESCRIBE** the general arrangement and signal flowpaths of the CIF Distributed Control System.

ENABLING OBJECTIVES

EO 2.01 **DESCRIBE** the physical layout of the CIF Distributed Control System components including the general location, how many there are, and functional relationship for each of the following major components:

a. High level links
b. Operator consoles
c. Multiloop controllers
d. Field termination cabinets
e. Foreign device interfaces
f. Programmable logic controllers

EO 2.02 **DESCRIBE** the CIF Distributed Control System flowpaths to include a drawing depicting the following flowpaths:

a. Analog process flowpath
b. Discrete process flowpath

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

TO 3.00 **DESCRIBE** the CIF Distributed Control System major components, available system and process indications, and available system and process controls.

ENABLING OBJECTIVES

EO 3.01 **EXPLAIN** the purpose of the following CIF Distributed Control System major components:

a. Operator consoles
b. Multiloop controllers (MLCs)
c. Programmable logic controllers (PLCs)
d. Distributed historian station (DHS)/VAX

EO 3.02 **EXPLAIN** the purpose of each of the following CIF Distributed Control System switches and the effects of each control on component operation:

a. DCS keyboard MONITOR-CONTROL switch
b. DCS keyboard TUNE-OPERATE-CONFIGURE switch

EO 3.03 **EXPLAIN** the purpose of the following keys located in the "Trend Set" section of the CIF Distributed Control System (DCS) keyboard:

a. SELECT key
b. STORE ON/OFF key
c. SHIFT □ and | keys
d. PAGE □ and | keys
e. TIME □| and |□ keys
f. SCALE ▼ key
g. ZERO ▲ key
h. CALL HISTORY key
i. DISPLAY RESET key

LEARNING OBJECTIVES (CONT.)

EO 3.04 **EXPLAIN** the purpose of the following keys located in the “Alarms” section of the CIF Distributed Control System (DCS) keyboard:

a. ACKNOWLEDGE key
b. SILENCE key
c. PRIORITY ALARM key
d. PRIORITY LIST key
e. TIME LIST key
f. HISTORY LIST key
g. SUMMARY LIST key
h. OUT LIST key
i. MODES 1 - 4 keys

EO 3.05 **EXPLAIN** the use of modes in the “Alarms” section, to include when modes would be changed and the effects on system operation when a mode is changed.

EO 3.06 **EXPLAIN** the purpose of the following keys located in the "Value Adjust" section of the CIF Distributed Control System keyboard:

a. FAST key
b. OUT ⎪and □ keys
c. SP ⎤and ⎞ keys

EO 3.07 **EXPLAIN** the purpose of the following keys located in the "Control Adjust" section of the CIF Distributed Control System keyboard:

a. A/M key
b. ON/OFF EXT key
c. ON/OFF RAMP key
d. ON/OFF COMP key
e. AUX key
f. ON/OFF LOC key
g. D1 (SP) and D2 (OUT)

EO 3.08 **EXPLAIN** why a CIF Distributed Control System controller would be operated in the "external" mode and what is meant by "external" mode of operation.

LEARNING OBJECTIVES (CONT.)

EO 3.09 **EXPLAIN** the purpose of the following keys located in the "Display Select" section of the CIF Distributed Control System keyboard:

a. PAGE □ and │keys
b. LEFT, RIGHT, and UP keys
c. LAST key
d. STORE and RECALL keys
e. MENU key
f. DISPLAY key
g. PLANT key
h. AREA key
i. GROUP key
j. GRAPHIC key
k. POINT key
l. TREND key

EO 3.10 **EXPLAIN** the information that can be obtained from the following types of displays:

a. Operator Display Hierarchy List
b. Analog/Discrete Point Pages 1-3

3.11 **EXPLAIN** the purpose of the CIF Distributed Control System SCRAM function to include:

a. Controls that initiate a scram
b. Automatic functions that initiate a scram
c. Actions that occur during a scram and the reason they occur

3.12 **EXPLAIN** the terms “permissive” and “interlock” as they pertain to operation of components from the DCS.

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

TO 4.00 Given necessary procedures or other technical documents and system conditions, **DETERMINE** the operator actions required for normal and off-normal operation of the CIF Distributed Control System including problem recognition and resolution.

ENABLING OBJECTIVES

EO 4.01 Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following:

a. Controlling equipment from the DCS
b. Making routine DCS configuration changes

EO 4.02 **EXPLAIN** the process of forcing a coil on the DCS, to include:

a. What is meant by forcing a coil
b. Hazards associated with forcing a coil
c. When a coil is allowed to be forced

EO 4.03 Given applicable procedures and plant conditions, **DETERMINE** the effects on the DCS and the operator's response during a full or partial loss of the DCS.

SYSTEM PURPOSE

Introduction

To control a complex process, components must be continuously monitored and adjusted in order to maintain efficiency and safety. Process variables from several components must be retrieved, analyzed, and corrective actions implemented in a short amount of time in order to maintain control. This task can be cumbersome and overwhelming to the human operator, but is well suited for a computer to manage. When there are hundreds of components to control, the task may be divided and managed by several computers

When several computers are used to control a process, each computer can be used to control a piece of the process. These computers, *distributed* throughout the facility, can monitor and control a piece of the facility, each acting independently of one another. Communications are necessary only to provide input to and output from the computers for operator control functions and indications, data storage, and limited cross communication between computer systems. A failure of one computer will not affect other computers, so that the remaining computers can continue to control their process. A system such as this is called a distributed control system.

The Consolidated Incineration Facility (CIF) includes 47 interconnected subsystems spread throughout the plant. Operation of these systems includes thousands of indications and controls. To ensure safe and efficient operation of the facility, many of the functions must be performed in concert with each other. To accomplish this task, a series of controllers operate and monitor groups of components under the shared command of the Programmable Logic Controller (PLC) and Multiloop Controller (MLC) systems. These systems, taken in their entirety, are referred to as the Distributed Control System (DCS).

System Purpose

EO 1.01	**STATE** the purpose of the CIF Distributed Control System.

The purpose of the Distributed Control System (DCS) is to monitor parameters of CIF equipment (to provide indication, adjustment, and alarms) and to control selected components within the CIF.

The DCS provides integrated automatic control of the fuel oil flow, combustion airflow, and kiln pressure for the incinerator. The DCS provides the operator interface, automatic process control, and trend/archival data storage for the CIF. The DCS uses a redundant High Level Link (HLL) for system communications and device configuration.

EO 1.02	Briefly **DESCRIBE** how the CIF Distributed Control System accomplishes its intended purpose**.**

The DCS accomplishes its intended purpose by receiving signals from field device sensors, analyzing these signals, and displaying system parameters on remote monitors. If a parameter is not within the programmed range, the DCS sends a correction signal to adjust field equipment based upon the signals received from the field device sensors. Remote console keyboards also allows the operator to control and monitor field equipment, system parameters, and system status.

ARRANGEMENT AND FLOWPATH

System Arrangement

EO 2.01	**DESCRIBE** the physical layout of the CIF Distributed Control System components including the general location, how many there are, and functional relationship for each of the following major components: a. High level links b. Operator consoles c. Multiloop controllers d. Field termination cabinets e. Foreign device interfaces f. Programmable logic controllers

The majority of the DCS System and PLC components are located in the Instrument Control Room (ICR), Instrument Equipment Room (IER), and the Electrical Equipment Room (EER).

The Instrument Control Room (Figure 1) contains five Operator Stations which serve as interface points between the plant equipment and operations personnel, three printers located adjacent to the operator's consoles, and a SCRAM relay. Partitions, around the outside of the DCS consoles, are installed to reduce noise and any outside distractions present during facility startup.

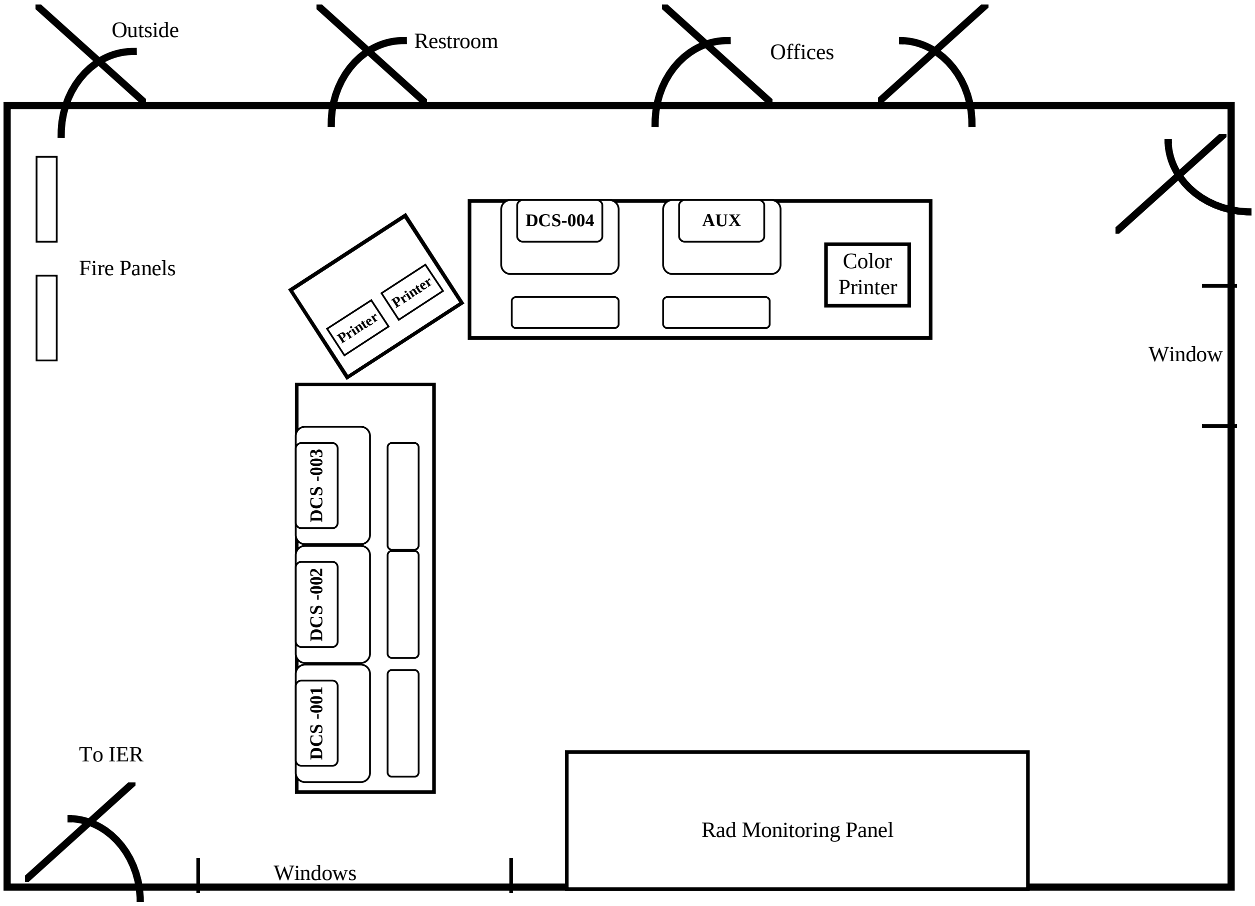

Figure 1 - Instrument Control Room

The Instrument Equipment Room (Figure 2) contains two Field Termination Cabinets (FTCs), four Multiloop Controller (MLC) cabinets, an Engineering Workstation (EWS), FDI/PLC Cabinets, and a VAX Data Archival System cabinet.

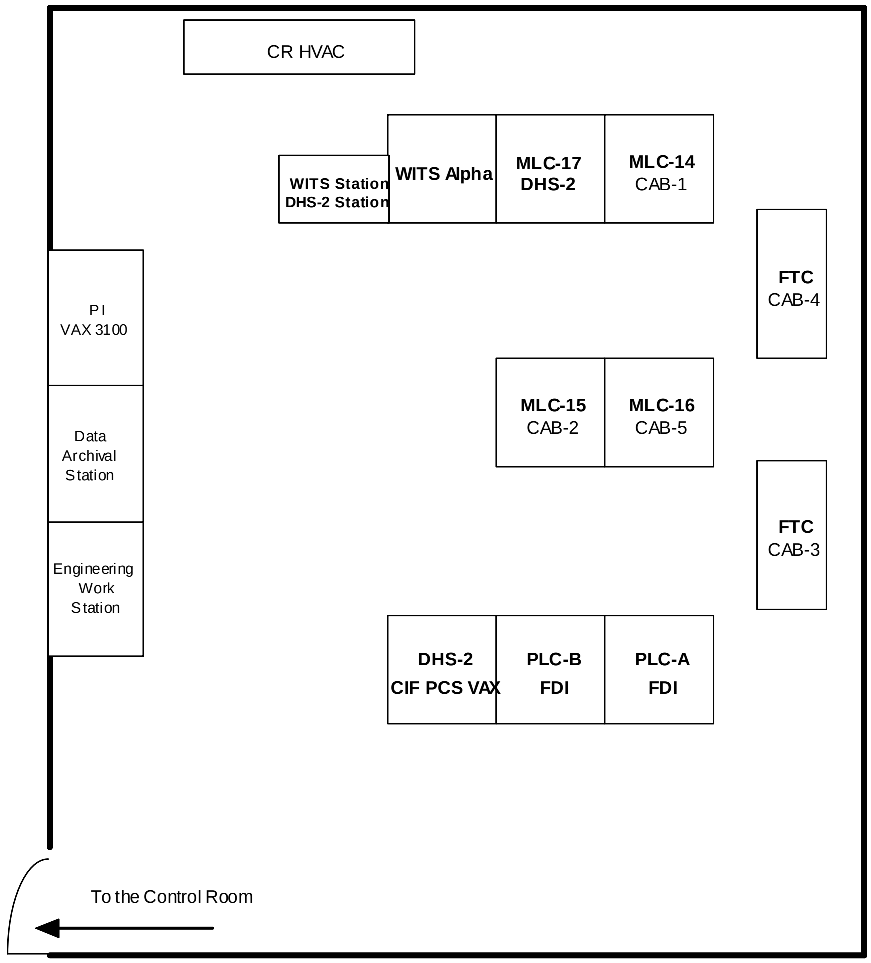

Figure 2 - Instrument Equipment Room

The Moore Products MYCRO operator stations provide a window by which a Control Room Operator performs the task of monitoring and interacting with the DCS. These functions are performed using the MYCRO operator keyboard and an interactive CRT screen. The keyboard resides close to the station monitor for easy access and enhanced hand-eye coordination.

In addition to the equipment located in 261-H, there is an alternate DCS console located in the 261-3H trailer. This console is primarily used for personnel who want to monitor the operation of the facility without interrupting the control room. For this reason, the console remains in the monitor mode. The console can be used as an alternate controlling station in emergencies, such as a control room evacuation.

DCS Flowpath

The network that connects all the major components of the DCS is referred to as the high level link (HLL). The HLL provides the "highway" for the information to travel to the various components of the Distributed Control System. The HLL consists of two separate highways to provide system redundancy. These highways are referred to as HLL-A and HLL-B. Figure 3 depicts this communication link.

This communication system allows the DCS to obtain information from the numerous field devices throughout the CIF. The HLL allows the operator to display the most current operational status of the plant.

The Facility PLC System, made up of two redundant Modicon 984B controllers, is one of the systems linked to other DCS components by the HLL. The operating PLC monitors and controls the CIF processes. The redundant PLC is a standby that automatically takes control should the primary PLC fail. This will minimize unplanned shutdowns in the event of the failure on the operating PLC.

The discrete data supplied to and from field devices are passed from the 984B controllers, using 120V signals, through 13 PLC input/output (I/O) Cabinets which are located throughout the CIF. The I/O cabinets then pass information from field devices (e.g. contacts for hand switches or control relays) back to the PLC where programming parameters dictate required actions. The communication link is also redundant.

In some cases, the PLCs will take necessary discrete actions. Other times; however, the PLC needs to pass specific information through a Foreign Device Interface (FDI) to the MLC (the FDI is a redundant unit consisting of two Moore FDIs). The majority of these discrete output signals operate motor starters located in the MCCs. The signals are also used to operate solenoid valves and to activate alarms on the consoles.

The ICR Operator's Consoles are each capable of displaying process data, equipment status, alarm status, and controlling all remote controlled devices. Commands from the operator's console through the MLCs to the field devices are accomplished in 200 milliseconds. Alarms for the MLCs are displayed in approximately 500 milliseconds and a graphics page call up can be completed within two seconds of the request. Alarms for the PLCs may take longer.

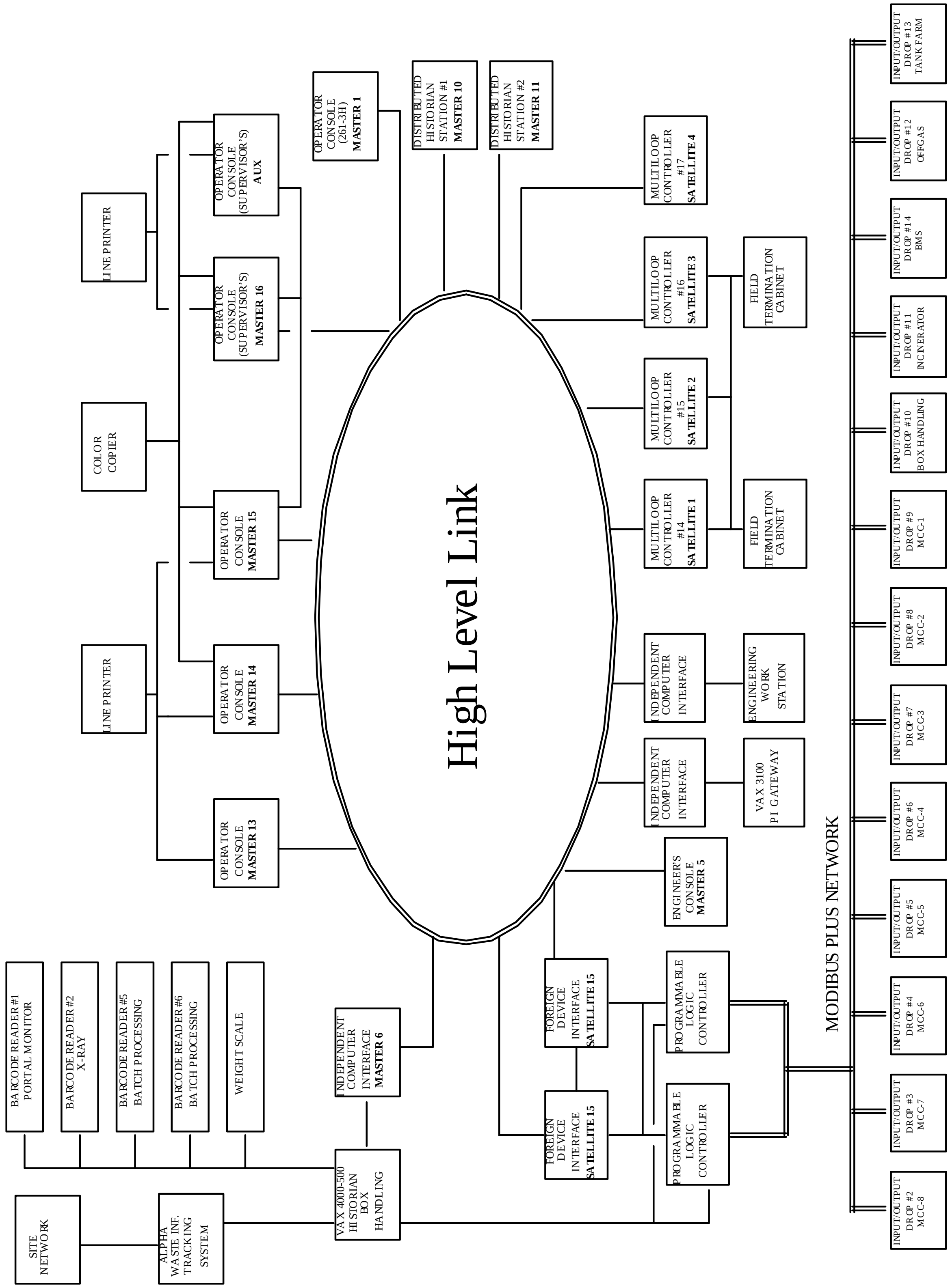

Figure 3 - High Level Link

MLCs interface with the field devices in order to send and receive analog data (there are eight MLCs, four redundant pairs). The information that is gathered from the field devices is in the form of Analog (4-20 mA dc) signals. These signals are passed through Field Termination Cabinets (FTCs) to the MLC. The MLC conditions and processes this information to control the process and alarms. The information is then processed to provide the operator console with a series of color faceplates and/or graphical displays. These color faceplates provide the interface for control and monitoring of the CIF processes.

<u>Discrete and Analog Flowpaths</u>

The DCS is configured to control both analog and discrete process information. Discrete information consists of controls to start and stop a pump, or controls to open and shut a valve. Analog process information consists of controlling system variables. The process signal flowpath for each type of signal is depicted in Figure 4.

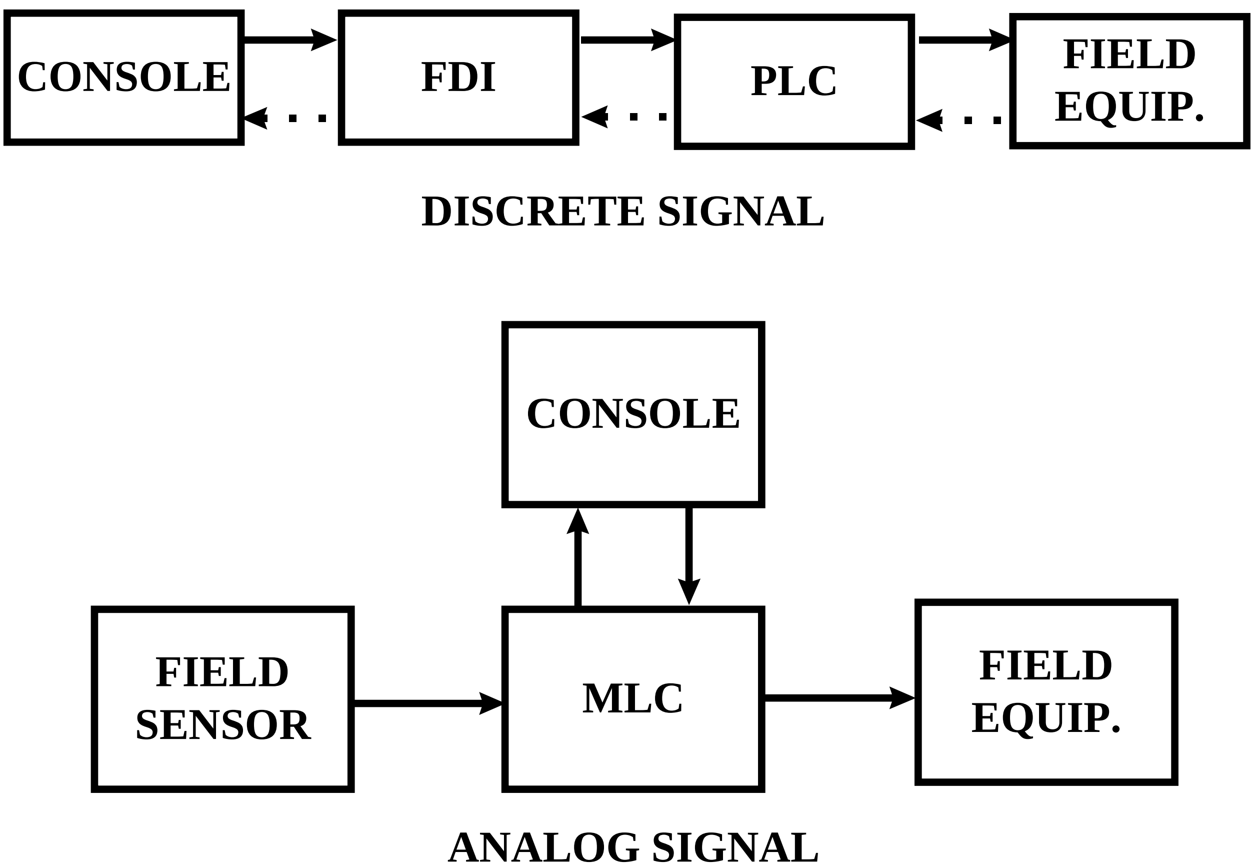

Figure 4 - DCS Process Signal Flowpaths

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For a discrete process, the operator selects a pump to start. Once the operator selects the pump and presses the D1 key on the console for the pump to start, a signal is sent from the console, through the foreign device interface, and to the programmable logic controller. In the programmable logic controller, the start signal is compared to other system interlock signals and makes a decision to start the pump. Once all system interlock signals have been satisfied, the control signal energizes the pump. The pump starts and a signal is returned to the programmable logic controller, through the foreign device interface, and then to the console to notify the operator that the pump has started. The same process occurs if the operator is stopping a pump or opening/closing a valve.

An easy example of an analog process is a system whose pressure is monitored and controlled by the DCS. The component used to control system pressure in this case is a control valve. While in the automatic mode of operation, system pressure is required to be maintained at a setpoint. When the pressure changes, a new pressure value is sent to the multiloop controller. Inside the multiloop controller, the pressure value is used as an input to a mathematical equation. If the pressure change is significant, an output signal is generated from the multiloop controller to a control valve to adjust itself and return system pressure to its normal operating setpoint.

MAJOR COMPONENTS

Introduction

The system hardware of the Distributed Control System (DCS) comprises the major components. These system hardware components work together to provide the monitoring and controlling of the field equipment for the CIF process.

The distributed control system used by the Consolidated Incineration Facility is a Moore Product Mycro DCS consisting of:

- Two High Level Links (HLL)
- Six Operator Consoles (three for operators, two for supervisors, and one alternate in 261-3H)
- Four Redundant Multiloop Controllers (MLC)
- Two Field Termination Cabinets (FTC)
- Two redundant Programmable Logic Controllers (PLC)
- Two redundant Foreign Device Interface Units (FDI)
- Three Independent Computer Interfaces (ICI)
- Two Distributed Historian Stations (DHS)
- One Engineering Work Station (EWS)
- One Engineer Console
- One Box Handling Archived Data Historian VAX 4000-500
- One Process Information (PI) VAX 3100

The multiloop controllers, foreign device interface units, and programmable logic controllers are redundant. Redundant means that each component is an independent unit that is separated into either a primary and controlling unit or a secondary and backup unit. If the primary unit fails, the standby unit takes over immediately with no loss of control to the CIF process.

High Level Link

The high level link is a redundant data highway. The high level link provides a communication pathway from one hardware device to another hardware device.

<u>Operator Stations (Consoles)</u>

EO 3.01	**EXPLAIN** the purpose of the following CIF Distributed Control System major components: a. Operator consoles b. Multiloop controllers (MLCs) c. Programmable logic controllers (PLCs) d. Distributed historian station (DHS)/VAX

The Operator Consoles (as shown in Figure 1) are each capable of accessing/displaying process data, equipment status, alarm conditions, and controlling all instrumentation and remotely controlled devices. Some of the parameters used by the computer for automatically controlling equipment include mass flow rates, temperature, valve positions, and PLC controller inputs. All seven Operator Consoles Stations are tied to the HLL.

Three stations are used by operators to manipulate and monitor plant equipment while the two remaining stations are dedicated as consoles for shift supervisors. In addition, one console acts as the alternate controlling station, located in 261-3H, and one console is used as an engineer's station, located in the IER. A typical example of the operating capabilities of the station consoles is provided in Appendix A - Console Manipulations. All plant operations can be performed on any one console.

The operator consoles are also connected to printers. The two supervisory consoles are connected to Printer Number 1. The operator consoles are only capable of accessing Printer Number 2. Only one console at a time is capable of printer access so a selector switch is provided to designate the console access.

One console in the control room is an auxiliary console. This console is not a master station, but rather sends and receives signals through another master station. The auxiliary console can be selected to operated through either DCS-003 or DCS-004. A selector switch, located underneath the cabinet, selects the auxiliary console's master station.

EO 3.02	**EXPLAIN** the purpose of each of the following CIF Distributed Control System switches and the effects of each control on component operation: a. DCS keyboard MONITOR-CONTROL switch b. DCS keyboard TUNE-OPERATE-CONFIGURE switch

Each of the station keyboards has two key switches that are used to establish keyboard operations.

MONITOR-CONTROL Key Switch

This key-operated switch actually has three positions: "OFF," "MONITOR," and "CONTROL." When in the "MONITOR" position, the operator is allowed to use the keyboard to call up and view displays only. In this position, no control functions can be made from the keyboard.

When the switch is in the "CONTROL" position, the operator is allowed to use the keyboard to display and control various components in the system. This position is used in conjunction with the TUNE-OPERATE-CONFIGURE key switch to perform certain functions.

When the switch is in the "OFF" position, no functions can be made from the keyboard. The "OFF" position disables the keyboard.

TUNE-OPERATE-CONFIGURE Key Switch

This key-operated switch has three positions: "TUNE," "OPERATE," and "CONFIGURE."

When the switch is in the "TUNE" position, the operator is allowed to manually change the alarm setpoints of the various controllers, place alarms in and out of service, change alarm modes, and change tuning parameters. When the switch is in the "OPERATE" position, the keyboard can be used for normal system operation, such as acknowledging alarms and change controller setpoints and for changing alarm modes. When the switch is in the "CONFIGURE" position, the keyboard can be used to make configuration (system) changes for the various monitor displays, such as changing colors, changing alarm descriptors, and changing printer assignments. A detailed list of privileges in each mode is listed in Appendix B.

Multiloop Controllers

The multiloop controllers provide analog and discrete process control functions. An analog control function is a function that has a varying state. For example, information supplied to the DCS for a level controller or level indicator is an analog function. A discrete process control function is typically any component that has two states associated with its operations. For example, a valve that is either open or shut is a discrete function. The four multiloop controllers are designated MLC-14, MLC-15, MLC-16, and MLC-17. The multiloop controllers receive input signals from field devices, process the input signals, and deliver output signals to the field devices. The MLCs mainly control components that have variable characteristics, such as flow or pressure regulating valves.

The use of four multiloop controllers is not for reasons of system redundancy. Each multiloop cabinet can house 64 control loops. When the system requires more than 64 control loops (as it does), then more multiloop controllers are needed. Multiple MLCs also allow the grouping of loops by process system. This means that all significant control actions in one process are controlled within the same processor (distributed control). For example, MLC-14 is used for off-gas, MLC-15 is used for the incinerator, MLC-16 is used for the tank farm, and MLC-17 only performs calculations.

The MLC is a satellite that is able to receive process information, calculate complex control strategies, and transmit output signals to the field via its local input/output hardware. The operator's console can be considered a "window" to the process that is used to both monitor and initiate control operations. Communications between the MLC and the operator's station are accomplished via the high level link.

An MLC control strategy is typically configured by selecting various pre-programmed algorithms and specifying addresses for their inputs and output. An algorithm is defined as a procedure and/or equation that a computer has been programmed to execute. Each algorithm can also be modified to suit specific applications. By linking a number of algorithms together, various complex control strategies can be developed.

The MLC has 128 "blocks," each of which can be thought of as a panel space that can contain one piece of hardware. Each block can be configured with one of the 31 pre-programmed algorithms. Each algorithm can be thought of as a physical piece of hardware that can be plugged into one of the 128 panel spaces. If the algorithms were actual pieces of hardware, they would be wired (or piped) together and then to their inputs/outputs via wires or pneumatic tubing. The algorithms in the MLC are instead soft-wired through the use of addressing.

Some blocks are specified to be loops, depending on the algorithm that has been selected to configure the block. A loop is a block, normally a controller, which can be monitored and controlled from either a CRT console or an independent computer. An MLC can have up to 64 loops with external outputs. An example of a loop is a flow controller for which the operator can monitor and control the flow, setpoint, value, and loop status from a single display on a CRT console. An operator, from a point display, can adjust setpoint parameters of a loop.

Each MLC cabinet contains two microprocessors. The microprocessors operate independently, with one as the primary and the other as the standby. The primary and backup are scanned every 200 milliseconds for normal operation. Should the primary microprocessor fail, the backup will automatically assume control without interruption of the system control and indications. An audible and visual alarm will occur, notifying the operator of the failure and the line printer will log a message of the incident.

Each MLC contains I/O cards, incoming signal terminals, signal conditioning, analog to digital converters, microprocessors, and memory required for processing and storing the value/status of incoming signals. Redundant power supplies for the operation of the terminal and the I/O cards are also self-contained. These redundant power supplies are dedicated to the microprocessors in each MLC.

Each MLC acquires the signals assigned to it, checks for failed sensors (<4 mA DC or >20 mA DC input signals), converts input signals to engineering units, checks against the process preset value/status limits (high/low alarm limits), generates alarms and return-to-normal messages, generates and provides data for the Data Archival System, executes equipment commands, and provides a sensor deviation alarm (i.e. compares sensors measuring the same process variable against each other, generating an alarm if a preset percent deviation is exceeded).

Each MLC can communicate with the operator consoles, field devices, Data Archival System, and PLCs over the HLL. Alarms are also provided to inform the operator in the event of total communications failure between the PLCs and MLCs.

The MLC I/O field termination cabinets (H-261-DCS-CAB-003 and H-261-DCS-CAB-004) are located in the IER adjacent to the MLC cabinets (Figure 2). The FTC contain the termination point for field signals for the four MLCs. The field termination cabinet can also serve as an isolating point between the field equipment and the control equipment. This feature becomes useful in the event of a failure of an instrument. All power within the FTCs is 24 VDC.

Programmable Logic Controllers

A programmable logic controller (PLC) is a microprocessor-controlled device used to provide discrete process control functions (programmed by the user to perform a specific task). PLCs control many components at CIF. Prior to the development and application of PLCs and other computerized process controls, industrial processes were controlled by a combination of human operators and electrical relays. As processes became larger and more complicated, the relay systems expanded to fill cabinets, walls, and entire rooms. In addition to the increasing number of relays, process downtime increased due to failure.

Not only did the processes become more complicated, they also required a much greater degree of accuracy, precision, and timing. The human operator found process control very difficult and time consuming when it required process timing to fractions of a second or component positioning to a fraction of an inch. PLCs were developed to allow timing accuracy and precision to microseconds and control of positioning to thousandths of an inch.

The redundant PLC is made up of two major sections, the input/output (I/O) section and the central processing unit (CPU). The I/O section is the interface between the central processing unit and the field devices. Field devices are components that supply signals to the PLC (input points) and components that are controlled by the PLC (output points). These field devices monitor and control the process components. The central processing unit governs and controls the operation of the entire PLC as directed by the user program. The PLC controls equipment that has two states, such as on and off or open and close. The PLC typically controls solenoid valves, pumps, and interlocks.

Input/Output Section

The input/output (I/O) section converts signals between values usable by the CPU and field devices. In the signal conversion, the signal is also conditioned to remove unwanted signals and surges.

A single PLC can monitor and control hundreds of I/O points (also called channels, groups, or devices). Input points and output points are normally on separate cards.

For an input module, the input value from the component in the field reaches the input module via field wiring and is landed on an input terminal strip. The input is filtered and conditioned to eliminate noise and surges. The input is then converted to a logic level DC voltage signal. The logic level DC signal is then sent to the processor through a signal isolator.

For an output module, the signal flowpath is reversed. The output module receives the signal from the central processing unit via a signal isolator. The logic level signal is amplified and used to control a switch. This switch controls an output point by switching a control signal.

The primary purposes of the I/O section are signal isolation and conversion between the central processing unit and the field devices. The I/O section can also serve as an isolating point between the field equipment and the control equipment. This feature becomes useful in the event the system needs to be locked out for repairs.

Central Processing Unit

The central processing unit (CPU) acts as the "brains" of the PLC. The CPU senses the status of the input points, makes decisions based on the status of these input points and the user program, and sends signals to control the output points. Also, the CPU provides information to and receives information from the high level link via the foreign device interface.

The purpose of the PLCs is to control and monitor the sequence of events that make up the processes of Low Level Waste Incineration. The two PLC cabinets (H-261-DCS-CPU-018 and H-261-DCS-CPU-019) located in the IER contain redundant Modicon 984B Controllers and associated interface equipment necessary to communicate with the DCS.

One of the controllers is designated as the primary controller, and it reads data, executes the required user programs from memory, and sends out appropriate commands to the field devices. The primary controller also provides updates to the stand-by controller with current status information after each scan of data.

The stand-by controller can process only status information, not control functions. The stand-by controller cannot control functions while the primary controller is functioning. When the primary controller is detected as failed, the stand-by controller will become active in less than 48 milliseconds. Control can also be transferred between controllers manually via a key switch.

Each PLC cabinet contains a display terminal with a keyboard for programming and operator monitoring functions of the FDI for bi-directional communication between the respective IER PLCs and the HLL.

PLC I/O Cabinets

Thirteen (13) Modicon PLC cabinets are provided. The PLC cabinets send and receive discrete I/O signals to and from the field devices through the 13 PLC input/output cabinets that are located throughout the CIF.

Eight PLC I/O cabinets are located in the EER (MCCs 2 through 9) and work with the motor control and associated components. The location of the remaining I/O cabinets are as follows: one at the Container Handling area; one at the Off Gas System area; two near the RK Incinerator (one is the Burner Management System PLC I/O); and one at the Tank Farm.

Identification for each of the 13 PLC I/O cabinets is through a drop number. The drop number ranges from drop #2 to drop #14, with the actual PLC being drop #1. Drop and cabinet numbers are as indicated in Table 1: (Each of the cabinet identification numbers, except for the BMS, will begin with the preface: H-261-DCS-CAB-. The BMS begins with H-261-BMS-PNL-)

Table 1 – PLC Drops

Cabinet #	Drop #	Location	Cabinet #	Drop #	Location
006	9	MCC-1	012	3	MCC-7
007	8	MCC-2	013	2	MCC-8
008	7	MCC-3	014	10	Box Handling
009	6	MCC-4	015	12	Off Gas
010	5	MCC-5	016	11	Incinerator
011	4	MCC-6	017	13	Tank Farm
002	14	BMS			

The PLC drop cabinets use digital signals from the PLC to control 120 VAC power. Typically, 120 VAC power for the MCC drops are fed from the associated motor starter as isolated I/O. Field switches and solenoid valves are fed by the PLC remote I/O cabinet as non-isolated I/O. In other words, the 120 VAC power supply to control a motor comes from the motor starter control power; the 120 VAC power to control a solenoid valve comes from the PLC drop cabinet.

Foreign Device Interfaces

The purpose of the foreign device interface is to act as an interpreter between the languages spoken by the PLC and the high-level link. This device is needed because the PLC software language is not compatible with the I/O addresses developed by the Moore company.

Independent Computer Interface

The purpose of the independent computer interfaces are to provide a means for a non-Moore Products Inc. computer to communicate with the Moore Product system. An independent computer interface is used to provide a link between the engineering workstation and the high-level link. Another independent computer interface provides a link between the VAX 4000-200 for box handling information and the high level link.

Distributed Historian Station

The purpose of the distributed historian station (DHS) is to record information about the CIF process. This information is used to aid operators, identify process trends, and CIF process information. The distributed historian station is located in the instrument equipment room adjacent to the control room.

There are two data historians, station #1 and station #2. Station #1 (Master 10) records all process data and status. Station #2 (Master 11) is dedicated to state required data. Data from both historians is archived to the VAX historian every four hours. The VAX data (older than 4 hours) is available from Master 6.

Engineering Work Station

The engineering workstation (EWS) is a tool used to monitor, modify, and troubleshoot the DCS. The engineering workstation is used by the DCS Engineers to make changes to the multiloop controllers, the programmable logic controller, and the distributed historian station. The engineering workstation is also used by the CIF cognizant system engineers to retrieve data from the distributed historian station. The engineering workstation is located in the electronics room adjacent to the control room.

Uninterruptible Power Supply (UPS)

The purpose of the UPS is to provide the normal source of stable, filtered 120V AC, 3-phase power to the various instrument loads and equipment of the DCS. The UPS is designed to keep the control system operable until emergency diesel power is available to the Motor Control Center (MCC). In the event of a loss of normal power from the MCCs to the UPS, the UPS will provide power from a battery bank to the DCS for a minimum of 20 minutes. This time limit will provide sufficient time for the CIF Standby Diesel Generators to come up to speed and tie on-line to various MCCs.

CONTROL CONSOLE KEYBOARD

Introduction

The keyboard of the control consoles is the interface between the Control Room Operator and the Distributed Control System (DCS). The keyboard allows the Control Room Operator to initiate commands to the Distributed Control System. The keyboard is used to control the DCS equipment that monitors, displays, and operates the Consolidated Incineration Facility equipment. The keyboard is divided into 13 separate sections. Figure 5 shows the keyboard used for the DCS.

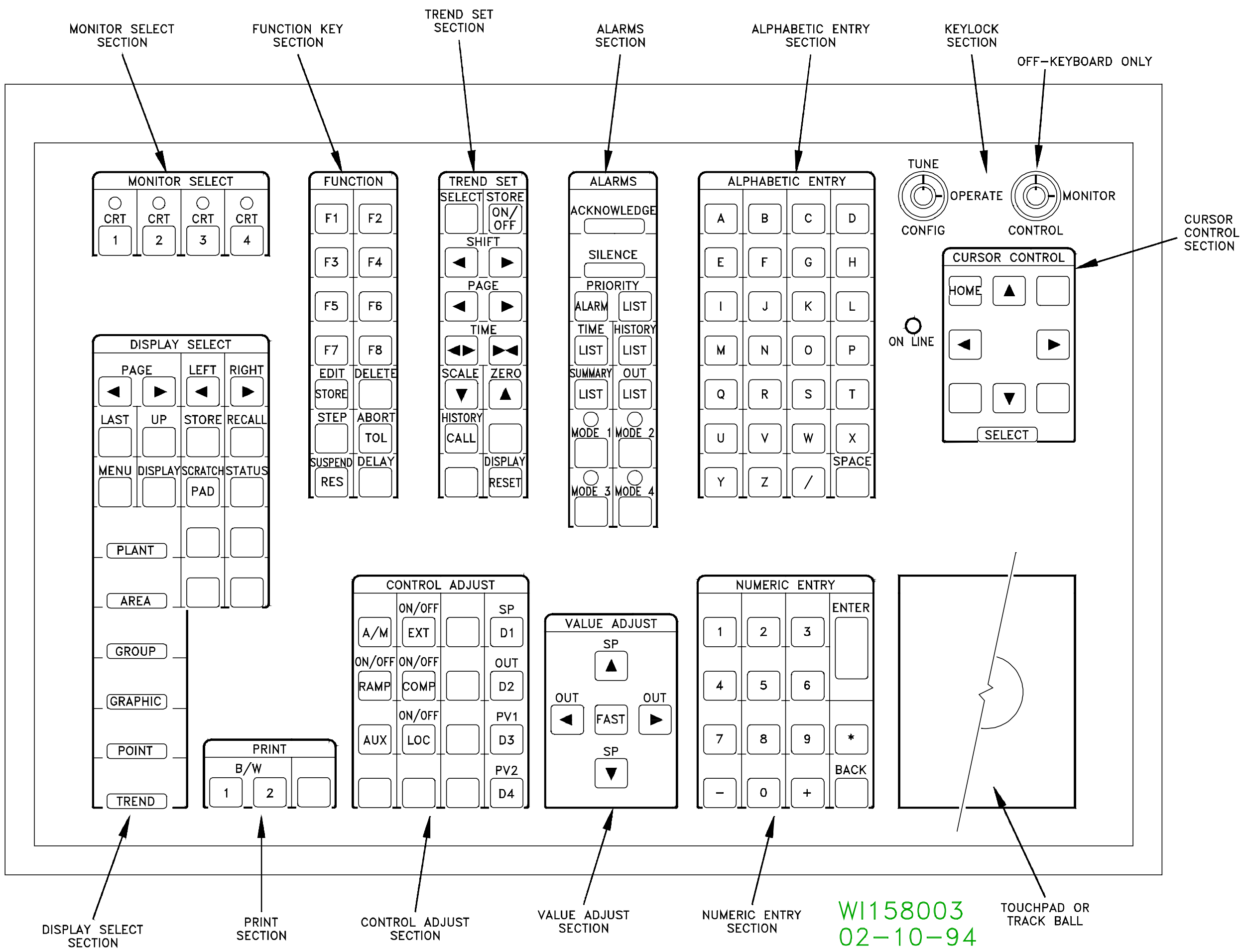


Figure 5 - DCS Keyboard

"Monitor Select" Section

The system is designed such that each console can have up to two monitors and two keyboards. Any keyboard can control any monitor, however, only one keyboard can be in control of a specific monitor at a time. The DCS Monitor Select keys allow the operator to select between monitors for observation of different operating parameters. However, this feature is not used at CIF.

As configured, DCS consoles 1 - 4 should be selected to CRT 1. The auxiliary console at the supervisor's station should be selected to CRT 2.

"Function Key" Section

The function keys are used to enter and recall pre-programmed configurations that are stored on disk. The "function key" section is not presently used by CIF configuration.

"Trend Set" Section

EO 3.03 **EXPLAIN** the purpose of the following keys located in the "Trend Set" section of the CIF Distributed Control System (DCS) keyboard:

a. SELECT key
b. STORE ON/OFF key
c. SHIFT □ and | keys
d. PAGE □ and | keys
e. TIME □| and |□ keys
f. SCALE ▼ key
g. ZERO ▲ key
h. CALL HISTORY key
i. DISPLAY RESET key

The keys in the "trend set" section are used for assigning local and distributed historian variables to be trended (graphed) and for manipulating variables as they are trended. Local trending occurs at each individual point tag displays (point page 1, discussed in a later section). Local trending has a limited time before the data is removed from the system. For longer trending, the data historian information is used on trend displays.

SELECT Key

The SELECT key in the "trend set" area of the keyboard is used to select a specific variable in a trend block when manipulation of the variable is desired and move the selected block from block to block on the trend displays.

STORE ON/OFF Key

The STORE ON/OFF key is used to store a selected point for trending or remove a selected point from trending, the trend index list and the trend summary list. This key is active only on the individual point tag displays needed for local trending.

SHIFT □ and | keys

The SHIFT □ and | keys are used to shift a variable in a trend block forward or backward in time. Each time one of these keys is depressed, the variable will shift at the programmed update rate entered for the variable entered in the trend summary list. These keys are active only on trend displays.

PAGE □ and | keys

The PAGE □ and | keys are used to page a variable in a trend block forward or backward in time. Each time one of these keys is depressed, a full page of data for the variable will be displayed. Only two pages can be depicted per trend. These keys are active in both local and historian trends.

TIME □| and |□ keys

The TIME □| and |□ keys are used to set the time period between the graduation lines: 2 minutes, 20 minutes, 1 hour, 2 hours, 10 hours, and 30 hours. Depressing the "□|" key increases the time period (wraps around to 2 minutes); the " |□" key decreases the time period (wraps around to 30 hours). These keys are active in both local and historian trends.

SCALE ▼ key

The SCALE ▼ key is used to move a variable on the plot so that it can be separated from other variables to be viewed and manipulated. This key adjusts the gain in increments of 1 (100%), 2 (50%), 3 (25%), and 4 (10%) each time the key is depressed. The 100% scale value wraps around from 10% to 100%. The 0% scale is unaffected by this function. This key is active only on historian trends.

ZERO ▲ key

The ZERO ▲ key is used to move a variable on the plot so that it can be separated from other variables to be viewed and manipulated. This key increases the % of scale value by 5% each time the key is depressed. The 0% scale wraps around from 95% to 0%. The gain is unaffected by this function. This key is active only on historian trends.

CALL HISTORY Key

The CALL HISTORY key is used to obtain data from the DHS. This data must be called and entered into a display information block on each display that it is to be plotted on. When calling data from the DHS, a full page of data is displayed if a date and time other than the current date and time are entered. If the current date and time are chosen, data is plotted as soon as the ENTER key is depressed. This key is active only on historian trends.

DISPLAY RESET Key

The DISPLAY RESET key is used to reset the display to normal trending after manipulations. All variables that have been manipulated are reset when this key is depressed.

"Alarms" Section

EO 3.04	**EXPLAIN** the purpose of the following keys located in the “Alarms” section of the CIF Distributed Control System (DCS) keyboard: a. ACKNOWLEDGE key b. SILENCE key c. PRIORITY ALARM key d. PRIORITY LIST key e. TIME LIST key f. HISTORY LIST key g. SUMMARY LIST key h. OUT LIST key i. MODES 1 - 4 keys

The "alarms" section of the keyboard allows the operator to silence and acknowledge alarming points, access alarm lists, and select the alarm mode in which the keyboard will be operated. Also, the "alarms" section of the keyboard allows the operator to display the appropriate alarming point faceplate with just one keystroke.

ACKNOWLEDGE Key

The ACKNOWLEDGE key is pressed to acknowledge an alarming condition. To acknowledge an alarm, the operator must highlight the appropriate faceplate on the group or point tag display that the alarm has been assigned, and then press the ACKNOWLEDGE key.

SILENCE Key

The SILENCE key is used to silence the audible alarm at the audible alarming console only from the operator's keyboard.

PRIORITY ALARM Key

The PRIORITY ALARM key allows the operator to call up, with one keystroke, the faceplate display screen of the highest priority first in alarm point. When the PRIORITY ALARM key is used, the alarm point is automatically highlighted. The operator only has to push the ACKNOWLEDGE key.

PRIORITY LIST Key

Pressing the PRIORITY LIST key calls up the alarm priority list. The priority list contains all active alarms for a given mode of operation in the order of priority, 1 through 4. Priority 1 is the highest priority and priority 4 is the lowest

If more than one alarm has the same priority, entries are listed with the most recent on top and oldest on the bottom. The priority number is located in the left-hand column of this display. The alarm priority, point tag, and active alarm message are entered for each active alarm.

HISTORY LIST Key

Pressing the HISTORY LIST key displays the alarm history list. The history list contains alarm events with the most recent at the top of the list and the oldest at the bottom. The list shows only those events that occur in the current alarm mode.

TIME LIST Key

Pressing the TIME LIST key calls up the alarm time list (see Figure 6). The time list contains the active alarms with the most recent on top and oldest on the bottom.

The “Alarms” section of the keyboard is used for process alarms only. Acknowledging system error alarms is possible only from the status pages.

Figure 6 - Alarm Time List

OUT LIST Key

Pressing the OUT LIST key calls up this list. The out list contains all points that have alarms out-of-service or alarms disabled. This list is frequently used during system startup to ensure all OOS or disabled alarms associated with the system will not affect system operation. If all alarms for a point tag are out of service, the tag number will be blue. Additionally, each of the four alarms associated with a point may be enabled or disabled, and the four columns next to the tag indicate this condition in green. If an alarm is disabled, interlocks associated with the alarm will not be active. If an alarm is out of service, the interlocks will be active, but the audible, visual, and printer indications will not operate.

EO 3.05	**EXPLAIN** the use of modes in the “Alarms” section, to include when modes would be changed and the effects on system operation when a mode is changed

MODE 1 - 4 Keys

These mode keys select the mode of operation for the DCS console alarms. The DCS can be configured to have four alarm modes that loosely define four different facility operating conditions. Each alarm on the DCS can change priority for each alarm mode. For example, if the incinerator was operating during mode 2 (warm standby) or mode 1 (operation), a fuel oil steam pressure alarm would be significant. In shutdown modes, however; this alarm would be a nuisance since the fuel oil burners are shut down. Consequently, changing alarm modes down to mode 3 disables the fuel oil steam pressure alarms, so that nuisance alarms do not occur.

Conversely, a breathing air alarm would be significant during modes 1 - 3 since breathing air can be used during these modes mode. Consequently, changing alarm modes from 1 to 3 does not affect these alarms.

During startup from cold standby to warm standby, the DCS is changed from alarm mode 3 to mode 2. This enables alarms necessary for an incinerator mode change to warm standby. Likewise, an incinerator mode change from warm standby to operation requires a DCS alarm mode change from mode 2 to mode 1. Mode changes are dictated by procedure, usually in the GOPs.

"Alphabetic Entry" Section

The "alphabetic entry" section allows the operator to input specific word or symbol entries. Typical entries are point tags and descriptors. The ENTER key in the "numeric entry" section must be pressed to complete an entry from this section.

"Keylock" Section

The two keylock switches are used to establish keyboard operations. The function of the keylock switches was previously discussed in the Major Components section of this study guide.

"Cursor Control" Section

The "cursor control" section allows the operator to move the cursor to highlight fields on displays for operator actions such as changing displays, changing tuning parameters, and making configuration changes.

Direction Key

The cursor can be moved in small increments by using the direction keys. To move the cursor to the left, the left arrow key is pressed; to move it down, the down arrow key is pressed, and so forth. When the operator gets to the appropriate selection, a white square line around the selection brightens, indicating the operator can now make that selection.

SELECT Key

When the appropriate field on the monitor display has been highlighted, the selection can be made by pressing the SELECT key. This action automatically activates the field for action.

HOME Key

Pressing the HOME key places the cursor in the left top corner of the display screen.

Touch Pad or Track Ball Section

The touch pad or track ball section of the keyboard allows the operator to move the cursor around on the monitor screen in order to make selections to be displayed. To get the cursor to appear on the display screen, the operator touches the touch pad or track ball. Once the cursor is brought up, the operator can move it around the screen and select other screens.

"Numeric Entry" Section

The "numeric entry" section allows the operator to input numerical values for a given command. After entering the number, the operator then presses the ENTER key in this section.

"Value Adjust" Section

EO 3.06	**EXPLAIN** the purpose of the following keys located in the "Value Adjust" section of the CIF Distributed Control System keyboard: a. FAST key b. OUT ⎢and □ keys c. SP ⎤and ⎞ keys

The "value adjust" section is used to change the setpoint or output signals of the three controllers, just as the SP and OUT keys in the "control adjust" section of the keyboard are used. The operator can use the keys in the "value adjust" section to change a setpoint or an output at the standard rate or a fast rate after first selecting the applicable key (SP or OUT) in the "control adjust" section.

FAST Key

The FAST key is used to increase the increment amounts that the setpoint or output signals change when the SP and OUT direction keys are pressed.

OUT Direction Keys

There are two OUT direction keys, one pointing left and the other pointing right. The left key is pushed to start throttling the controller associated valve(s) "CLOSED." The right key is pushed to start throttling the controller associated valve(s) "OPEN."

SP Direction Keys

There are two SP direction keys, one pointing up and the other pointing down. These keys are used to change the setpoint of the controller when the controller faceplate is selected with the cursor. The up key raises the setpoint of the controller and the down key lowers the setpoint of the controller.

"Control Adjust" Section

EO 3.07	**EXPLAIN** the purpose of the following keys located in the "Control Adjust" section of the CIF Distributed Control System keyboard: a. A/M key b. ON/OFF EXT key c. ON/OFF RAMP key d. ON/OFF COMP key e. AUX key f. ON/OFF LOC key g. D1 (SP) and D2 (OUT)

The keys in the "control adjust" section are used to make control adjustments. Typical control adjustments include changing control modes, changing setpoint and process variables, and sending discrete commands.

A/M (Automatic/Manual) Key

Enabling the A/M key allows the operator to switch the control mode of a point between automatic and manual. The operator can change the control mode from any of the point pages or from an operator display.

EXT (ON/OFF) Key

EO 3.08	**EXPLAIN** why a CIF Distributed Control System controller would be operated in the "external" mode and what is meant by "external" mode of operation.

Enabling the EXT (External) ON/OFF key allows the operator to switch between an external setpoint and a local setpoint for a multiloop controller loop to control a process parameter. The external setpoint originates at a source other than a master station on the high level link. Controlling a DCS controller externally means a process parameter is being controlled by varying another process parameter. This type of control is desired when a change in one parameter needs to be corrected by changing another parameter. An example of a CIF process parameter being controlled externally is fuel oil burner steam pressure. The MLC does not control steam pressure itself, rather it automatically control steam pressure based on fuel oil pressure to maintain a minimum 15 psid value.

RAMP Key

Enabling the RAMP key allows the operator to have a setpoint to a multiloop controller incrementally changed (ramped) to a predetermined value (ramp target setpoint) in a predetermined period of time (ramp time).

A DCS controller is ramped to minimize transients in the system (e.g., ramp up to purge the incinerator prior to light off), and to control the heatup rate of the incinerator. The ramp time and ramp target setpoint are tuning parameters entered in the tuning parameter area of the DCS point page display screens. An operator can tell if a DCS controller is being ramped from the applicable controller faceplate. The faceplate will indicate "AUTO RMP" for the controller operating mode. An operator can tell if a DCS controller is being ramped from the applicable point page display or faceplate display by observing the control setpoint being automatically changed in small increments until the target setpoint is reached.

COMP (ON/OFF) Key

Enabling the COMP (Computer) ON/OFF key allows the operator to switch the control source of a point between, for example, a console and an independent computer via an independent computer interface. At CIF, this control stays "OFF."

AUX (Auxiliary Adjuster) Key

Enabling the AUX key allows the operator to define a point's auxiliary input (e.g., air/fuel ratio) for a manual controller entry.

ON/OFF LOC Key

This key is not currently used at the CIF.

D1 (SP) Key

Enabling the D1 SP (Setpoint) key allows the operator to enter a specific value for a setpoint for an analog function. For a discrete function, it is used to change the output value (e.g., start a pump).

D2 (OUT) Key

Enabling the D2 OUT (Output) key allows the operator to enter a specific value for an output for an analog function. For a discrete function, it is used to change the output value (e.g., stop a pump).

D3 (PV1) and D4 (PV2) Key

For discrete functions, the D3 and D4 keys can be used to change the output value for additional functions. For example, a discrete function for starting and stopping a pump typically has only D1 and D2 enabled, but when there are more than two functions, the D3 and D4 keys may perform additional functions. For example, for pumping the stack sump, D1 opens the valve to AQW, D2 opens the valve to the outfall, D3 opens the valve to the scrubber recirculation tank, and D4 closes all valves.

<u>“Print Section”</u>

The print keys initiate printing of screen data on a designated printer. This keyboard feature is particularly useful for creating hard-copy documentation of system configuration or for documenting significant process events for later analysis. Button #1 is depressed to select the black and white printer, while Button #2 is depressed to select the color printer.

<u>"Display Select" Section</u>

EO 3.09	**EXPLAIN** the purpose of the following keys located in the "Display Select" section of the CIF Distributed Control System keyboard: a. PAGE □ and │keys b. LEFT, RIGHT, and UP keys c. LAST key d. STORE and RECALL keys e. MENU key f. DISPLAY key g. PLANT key h. AREA key i. GROUP key j. GRAPHIC key k. POINT key l. TREND key

The "display select" section of the keyboard allows the operator to move through displays without having to select screens using the touch pad or track ball. From this section, the operator can call up the MAIN MENU, various operator displays, points, and status pages. The operator can also page through alarm and trend lists, move left or right in the operator display hierarchy, and store and recall selected displays. The display section allows the operator to call up various screens on the video terminal.

PAGE □ and │Keys

The PAGE □ and │keys allow the operator to page through displays if more than one page is associated with the display. The page number of the display is identified at the top of the monitor screen display. Using the PAGE keys allow the operator to display the next or previous page on the monitor screen, as configured by the display hierarchy.

LEFT and RIGHT Keys

The LEFT and RIGHT keys are used by the operator to page between adjacent displays.

UP Key

Pressing the UP key calls up the next highest hierarchy level display.

LAST Key

Pressing the LAST key automatically calls up the screen display that preceded the one presently displayed on the monitor screen.

STORE and RECALL Keys

The STORE and RECALL keys allow the operator to store and recall up to 10 different displays. Any display can be stored for recall. These keys are used at the operator's discretion. Typically, a display that is currently being used often is chosen to be stored.

To store a current display, the operator presses the STORE key. The prompt "ENTER SCREEN NUMBER (1-10)" appears at the bottom of the screen. The operator types in the number and presses the ENTER key in the "numeric entry" section of the keyboard. The display is then stored under that screen number.

To recall a display from memory, the operator presses the RECALL key and the prompt "ENTER SCREEN NUMBER (1-10)" appears at the bottom of the screen. The operator then presses the number key(s) for the appropriate display and presses the ENTER key. The display appears on the monitor screen.

MENU Key

The MENU key allows the operator to access the display selection menu. The menu contains selections for displaying an operator display hierarchy list, a point list, a trend list, a function list, and a system configuration. Each display is selected by highlighting the associated display and pressing enter. The displays and the information each contains is discussed later.

DISPLAY Key

Pressing the DISPLAY key causes the following message to appear at the bottom of the monitor screen: "SELECT OPERATOR DISPLAY." This action allows the operator to enter the appropriate display number of the screen desired from the "numeric entry" section and push the ENTER key.

STATUS Key

The STATUS key brings up the status displays which provide diagnostic and database information for the high level link, and all devices on the high level link, both master and satellite. These displays show the various system elements that are connected, their current state, and how they are functioning.

The DCS provides numerous graphic displays to give the CRO the level of information needed to perform a particular task. These displays are presented on the video terminal screen on the console used by the CRO. Monitor screen displays are generally one-line graphics, status reports, and data trends.

Pictorial or schematic flow diagrams, single-line diagrams, and equipment sketches of plant systems and equipment are available for the operator to monitor and control. The displays contain alphanumeric and graphic symbols that are programmed to change color, to change shape, or to blink, representing changes in the equipment or monitored process variable state.

The displays are arranged in hierarchical order. From an overview, selection of a top level process or system display is available. Monitor screen displays are accessible by direct functions, by using the menu, by paging between adjacent displays, or by placing a cursor on the monitor screen on a currently displayed element of a graphic page, status page, or alarm line and pressing the SELECT key.

The displays are constructed while the DCS is off-line (system not operating) using preformatted blocks, symbols, and characters. From these displays, the operator can view active process data and interact with the process for control purposes. Examples of typical preformatted blocks and symbols are shown in Figure 7.

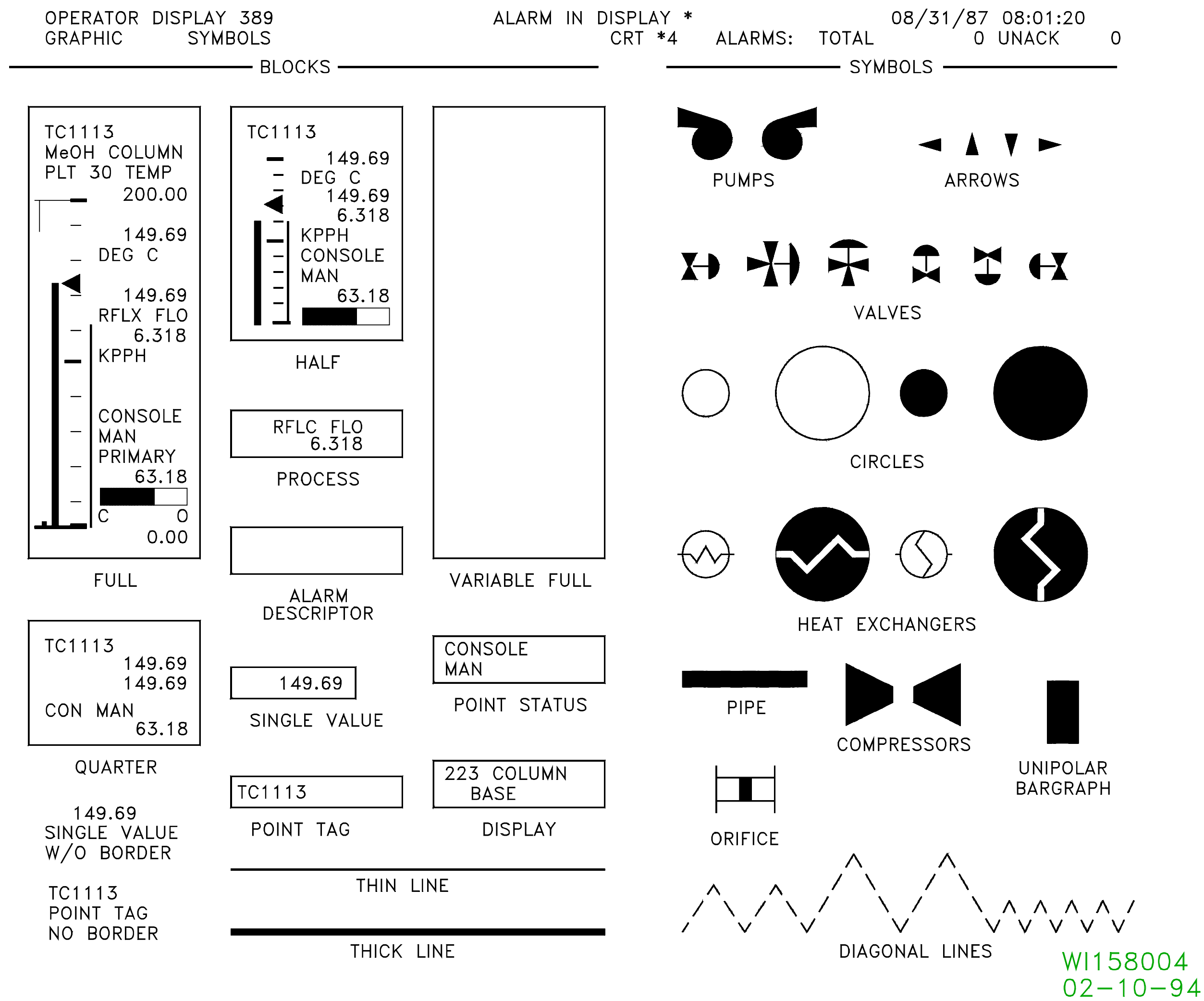


Figure 7 - Typical Blocks and Symbols

PLANT Key

The PLANT key calls up the plant display (Figure 8). The plant display shows an overview of the entire plant, including the RK, SCC, and Off-gas System areas (display 800). Each of the blocks gives the DCS display number for the specified area or control display. This display also provides a digital indication of some of the key plant indications. Like all other DCS displays, this screen provides the operator display number, the display name, the current date and time, the total number of actuated alarms, the number of unacknowledged alarms, and an alarm in display number indication.

Figure 8 - Plant Display

AREA Key

The AREA key calls up an area display, which corresponds to areas of the plant (Figure 9). These areas are the Tank Farm System (801), the RK System (802), the SCC System (803), Off-gas Page 1 (804) , and Off-gas Page 2 (805). The area displays provide the operator with a more detailed overview of a specific CIF process area. Each of the major system components in the applicable CIF area is represented in a block layout. Each of the blocks gives the DCS display number for the specified major component. The area displays also provide a digital indication of some of the key indications associated with the components in the applicable area. Like all other DCS displays, this screen provides the operator display number, the display name, the current date and time, the total number of actuated alarms, the number of unacknowledged alarms, and an alarm in display number indication.

GROUP Key

The GROUP key calls up a group display (refer to Figure 10). Faceplate displays allow the operator to look at each individual item that is associated with the graphic. Faceplate displays are typically full blocks or half blocks.

The DCS group displays depict the equipment/isolation valve (discrete) and instrument/controller-operated valve (analog) faceplates for the associated graphic display and indicate any associated actuated alarms. The discrete faceplates indicate the current equipment status and the control keystrokes required for changing equipment states (opening and shutting valves or selecting, starting, and stopping pumps).

The analog faceplates indicate the instrument range, the current instrument reading, the control setpoint for controlled parameters, the alarm setpoints for any associated alarms, and the percent valve loading (valve position) for control valves. Current instrument readings (such as tank levels and flow rates) are indicated by a numerical reading in the associated faceplate and by a pointer on the scale on the left-hand side of the faceplate. Controller-operated valve position can be determined by looking at the horizontal bar indicator in the lower right-hand corner of a control valve faceplate or by noting the numerical value above this bar.

Like all other DCS displays, this screen provides the operator display number, the display name, the current date and time, the total number of actuated alarms, the number of unacknowledged alarms, and an alarm in display number indication.

Figure 9 - Area Display

Figure 10 - Group Display

GRAPHIC Key

The GRAPHIC key automatically displays the next hierarchy screen graphic associated with the screen currently displayed on the monitor. The graphic displays are useful in showing a dynamic process, such as lighting of fuel oil or waste burners. The graphic displays can also be accessed by using the DISPLAY button and entering the associated graphic display number. Typically, there is a graphic display for each group display.

Graphic displays are basically one-line diagrams of various portions of the CIF process systems. The graphic displays are graphics that are created to represent a CIF System or portion of a CIF system. A CIF graphic display provides the operator with an indication for all monitored parameters for the system/component depicted on the associated graphic.

Most tank levels are depicted using two methods on a graphic display. The tank level can be roughly determined by noting the colored in portion (amount colored in is proportional to water level) of the tank silhouette. The exact tank level is depicted by a numerical indication. If a flow rate is monitored, the flow rate is given by a numerical indication. Controller operated valve position and the controller mode of operation can be determined by placing the screen cursor on the graphic representation of the controller to pull the controller faceplate in the block in the upper left-hand corner of the screen. The position of pneumatic isolation valves can be determined by noting the color of the valve silhouette. An open valve is depicted as a green silhouette. A closed valve is depicted as a red silhouette. Throttled valves indicate both green and red.

The operational status of pumps represented in the graphic display can also be determined by noting the color of the pump silhouette. A running pump is green, a shut down pump is red. Other monitored parameters are also depicted on the graphic displays using digital readings. System interfaces are depicted in a block format that also shows the DCS display number for the associated interface.

Like all other DCS displays, this screen provides the operator display number, the display name, the current date and time, the total number of actuated alarms, the number of unacknowledged alarms, and an alarm in display number indication.

If an operator desires more detailed information for a piece of equipment depicted on a graphic display than is available on the display, the operator can call up the associated equipment faceplate on the graphic display by placing the screen cursor on the desired piece of equipment. This will place the associated faceplate in the block in the upper left-hand corner of the display as previously described.

POINT Key

Point tag pages can be called for display by pressing the POINT key. This is accomplished by pressing the point key, entering the alphanumeric point tag designator, and pressing enter.

TREND Key

The TREND key is used to call trend displays that include a variable that the operator wishes to view. The trends are configured on the trend index list display, discussed in a later section.

DCS DISPLAYS

Menu Display

The displays that appear on the screen of the monitor are arranged in hierarchical order. From an overview, selection of a top level process or system display is available. To determine the hierarchical order of the screens, the operator can call up the list of all of the display screens that are configured in the DCS. This is accomplished by first calling up the "MENU" display. The "MENU" display can be used to access major DCS lists and/or displays. Figure 11 depicts the "MENU" display.

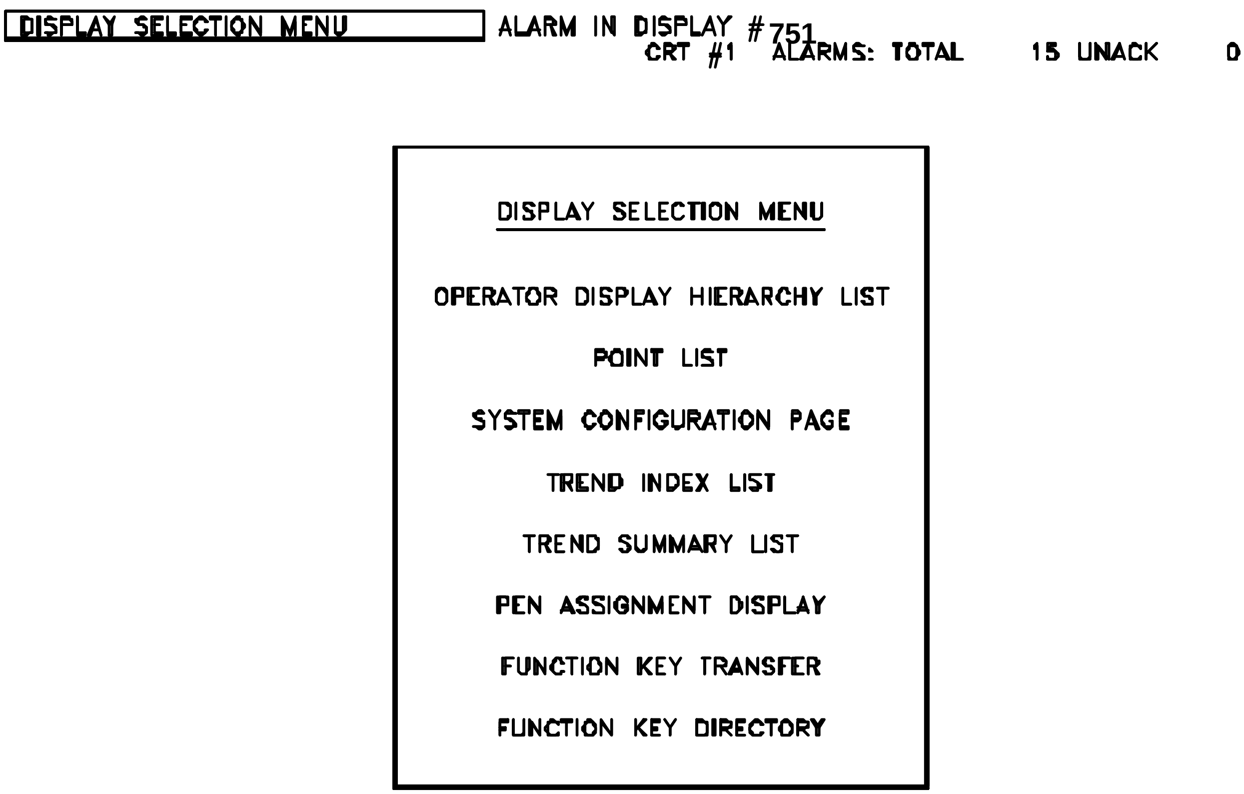


Figure 11 - Menu Display

"Operator Display Hierarchy List"

EO 3.10	**EXPLAIN** the information that can be obtained from the following types of displays: a. Operator Display Hierarchy List b. Analog/Discrete Point Pages 1-3

Each available system display is given a different display number to distinguish it from other displays. The various display numbers used are located by selecting and calling up the OPERATOR DISPLAY HIERARCHY LIST" from the "MENU" screen.

The operator hierarchy lists every graphic and group (faceplate) screen that is available to be called up on the monitor. The operator hierarchy list is shown in Figure 12. This information can be used to locate the display number associated with a particular system.

The first column is titled "DSPL #" for display number. This column indicates the display number given to each available screen. If the operator wants to go to a particular screen without operating the cursor to select it, the operator can come to this list, find a particular display number, and enter it in the keyboard.

The second column is titled "DESCRIPTOR." This column describes the title of the display screen. These titles correspond to a specific ETF process or component.

The third column is titled "PLANT." This column gives the operator the display number that appears from this screen if the PLANT key in the "display select" section of the keyboard is pressed. The DCS can be configured to control more than one plant. At CIF, CIF is the only plant controlled by the DCS. The plant is broken into subsections called areas.

The fourth column is titled "AREA." This column indicates the display number of the screen that is called up if the AREA key in the "display select" section of the keyboard is pressed.

The fifth column is titled "GROUP." This lists the display number that is called up on the monitor screen if the GROUP key in the "display select" section of the keyboard is pressed.

The sixth column is titled "GRAPHIC." This lists the display number that is called up on the monitor screen if the GRAPHIC key in the "display select" section of the keyboard is pressed.

The seventh column is titled "LEFT." This lists the display number that is called up on the monitor screen if the LEFT key in the "display select" section of the keyboard is pressed.

Figure 12 - Operator Display Hierarchy List

The eighth column is titled "RIGHT." This lists the display number that is called up on the monitor screen if the RIGHT key in the "display select" section of the keyboard is pressed.

The ninth column is titled "UP." This lists the display number that is called up on the monitor screen if the UP key in the "display select" section of the keyboard is pressed.

Points and Trending

A point is a digital or analog signal monitored by the DCS. A point tag is the point number and letter coding assigned to each point.

When trending (plotting), the point tag and designation number for the desired parameter to be trended must be known. The trend designation number is the designated code number for the desired variable from the plot. This can be 1, 2, 3, or 4. A designator number of 1 means this is process variable No. 1 for the associated point tag. A designator number of 2 means this is the setpoint for the associated point tag. A designator number of 3 means this is process variable No. 2 for the associated point tag. A designator number of 4 means this is the valve (plots percent valve position) for the associated point tag.

Trends (plots) are an operator aid that can be used to monitor for variance (trends) in a process parameter. Trends are also used by engineering personnel to monitor process/ equipment performance and monitor for adverse trends in process parameters. Process parameter variables can be trended at different rates (rate of plotting). The rates used by the DCS during trending can be set at 1 second, 10 seconds, 30 seconds, 60 seconds, 300 seconds, and the slowest trend rate is 900 seconds. If a trend rate is not entered, the trend rate will default to every 10 seconds.

A Trend Summary List and a Trend Index List can be accessed from the DCS "MENU" screen. The Trend Summary List is used for local trending only (trending on a CRT monitor). The Trend Summary List contains a listing of all points stored locally, their update rates, and the up display numbers (up units).

The Trend Index List contains a numerical listing of trend displays from the DHS, the type of display, and the variables assigned to each display (maximum of four).

Point Pages

Three types of point pages are used to display detailed information about a point. From these point pages, the operator can view real-time plots of selected variables, initiate control and value adjustments, and silence and acknowledge alarms. Both analog and discrete point pages are similar in function and information contained.

Analog point page 1 is used only when the DCS is on-line and contains a real-time plot of analog point variables or discrete point input channels. Analog point page 1 is also used with the analog points when tuning controllers. When the DCS is off-line, point pages 2 and 3 are used to specify and enter all required information for the DCS operation of a point. When the DCS is on-line, point pages 2 and 3 are used primarily as references and to make limited configuration changes to the DCS. Point pages 1 and 2 are typically used by the operator, and will be discussed in this section.

All point pages can be called for display by selecting from an operator display or by pressing the POINT key in the "display select" section of the keyboard. For example, the operator presses the POINT key, types in the point tag such as OGQ3100LC-1, then presses ENTER.

The operator may move between point pages by using the PAGE keys and the LAST key in the "display select" section. The "<" and ">" PAGE keys select lower and higher numbered pages, respectively. The LAST key selects the previously displayed page.

Each point page has common information displayed at the top. This information consists of the point page number, the alarm in display number, the date, the time, the point tag, the point name, the CRT number, and the total and unacknowledged alarms. The point tag is also used to indicate the status of alarms configured for a point. The point tag may blink, change foreground and background colors, or remain steady, depending upon the alarm condition.

Point Page 1

An illustration for an analog point page 1 is provided in Figure 13.

Faceplate Area

The faceplate on point page 1 (located on the far right area of the display) displays default information entered in the faceplate on point page 3. This information is entered when the DCS is off-line for the configuration of point page 3.

Plot Area

The plot area (located in the large section of the display) plots up to four variables for an analog point. These variables are process variable #1, the setpoint, process variable #2, and the output. For a discrete point, the plot area plots up to four input channels, on or off.

Figure 13 - Analog Point Page 1

When a point is selected for display, point page 1 appears on the screen. If the point has been assigned to local trending, one full page of the trended data fills the area. Real-time plotting begins at this time. (Trending is another term for plotting.)

If the point has not been assigned to local trending, the plot area is blank at first, and then begins plotting real-time data and continues plotting until the operator exits the point. While in the point, the operator may move between point pages, and the data continues to be plotted.

Analog variables are plotted in the same color as they appear in the faceplate; discrete channels are plotted in their on or off state foreground and background colors as they appear in the faceplate. Data is plotted to the left as time passes.

The plot area is divided into four sections by vertical graduation lines. The time is displayed under each graduation line. Starting with the right most line, the current time is displayed. The time difference between each successive graduation line to the left is equal to a time period that is selected by the operator. To select a new time period, the operator uses the "<>" and "><" keys in the "trend set" section. The time periods that can be selected are 2 minutes, 20 minutes, 1 hour, 2 hours, 10 hours, or 30 hours. The operator presses the "<>" and "><" keys to increase and decrease the time periods, respectively, as desired.

Trend Rate Area

The trend rate area (located in the lower left-hand corner of the display) determines how often the plot is updated. The operator can select the trend rate. Using the cursor controls, the operator highlights the trend rate, for example, 1 SEC, then presses SELECT in the "cursor control" section. The TUNE-OPERATE-CONFIG switch must be in “CONFIG.”

Plot Variable Enable/Disable Area

The plot variable enable/disable area determines which of the four possible analog variables or discrete input channels is plotted. Each variable or channel is automatically plotted unless it is removed from the plot. The operator can remove any variable or channel from the plot, and can also reinstate that variable or channel.

Analog variables are numbered 1, 2, 3, and 4, for process variable #1, the setpoint, process variable #2, and the output, respectively. Discrete channels are numbered 1 through 4 for input channels 1 through 4, respectively.

Alarm Settings Area

The alarm descriptor and settings entered on point page 2 are displayed in this area. The alarm settings can be changed in this area, but the alarm descriptor may not be changed.

Active Alarm Message Area

Each point can have a maximum of four alarms configured. For each alarm, an alarm message is entered to explain the nature of the alarm. When any of the alarms become active, the applicable message is displayed in this area.

Analog and Discrete Point Page 2

An example for an analog point page 2 is depicted in Figure 14.

Faceplate Area

The faceplate area (located on the right-hand portion of the display) on point page 2 displays the dynamic and static information entered in the faceplate on point page 3. Dynamic information is information that is constantly changing. For example, dynamic information found in the faceplate area includes level changes, temperature changes, and throttle valve position changes. Static information is information that is not changing. For example, static information found in the faceplate area includes the names for various points and the setpoints. This information is entered when the DCS is off-line to configure point page 3.

Alarm Enable/Disable Area

Each point can have up to four alarms configured. Different alarm types are available, in addition to system operating representations, as follows:

- High or Low values - these alarms can be set when the parameter is above or below the desired setpoint. Multiple high or low alarms can be configured. High or low tank levels are examples of these types of alarms.
- Deviation - these alarms can be configured so that alarms occur when two monitored parameters deviate from one another greater than a specified value. An example of a deviation alarm is on the quench recirculation pH indication. If the two pH indicators differ by more than 0.5 pH units, an alarm will occur.
- C (Calculation): discrete only; no indication on the faceplate. A calculation can be alarm that occurs due to a DCS calculation, or from an external device, such as a pressure switch.

Figure 14 - Analog Point Page 2

The DCS can be configured to have four alarm modes that define four different operating conditions. These four modes are selected in the "alarms" section of the keyboard. Each of the four alarms, 1 through 4, are enabled or disabled as required for operation in the applicable mode. The “Alarm Out List” will display enabled or disabled for each alarm associated with the specific point tag.

For each alarm mode, a priority of 1 through 4 is assigned. The DCS allows a priority of 1 through 9, but only 1 through 4 is assigned at CIF. The highest priority is 1. The priority denotes the relative importance of a point when any of its alarms are active in a given alarm mode. A general condition for each priority is as follows:

- Priority 1 - Alarms associated with safety significance
- Priority 2 - Alarms associated with an environmental release
- Priority 3 - Alarms associated with equipment failure
- Priority 4 - Alarms that are print only

Any alarm that is not programmed in the DCS will default to priority 5. These alarms, if identified, must be reported to the DCS Engineer for correction. Points in alarm are placed in the Priority List according to this priority assignment or the order the alarms are received if the alarms have the same priority.

Alarm Indication Area

In the alarm indication area, each of the four alarms can be configured to enable or disable the indications associated with the alarm. Along the top row of the area, “P,” “A,” and “V” are displayed. These areas correspond to printer, audible, and visual. This area can be used to enable or disable an alarm from printer, audible, visual indications.

All four alarms can be taken out of service simultaneously by configuring the “Alarms in Service (Y/N)” message. When the message indicates “Y,” all alarms actuate as indicated by the “P-A-V” settings. When the message indicates “N,” all alarms are out of service. This will be indicated on the “Alarm Out List” by the point tag number indicating blue.

Individual alarms can be disabled. This will be indicated colored green on the Out List. Disabled alarms can bypass the interlock associated with it. If the alarm/interlock is originated in the MLCs (analog alarm), it is bypassed when disabled. If the alarm/interlock is originated in the PLCs (discrete alarm, C type), the interlock is not bypassed or disabled.

CONTROLS AND INTERLOCKS

SCRAM

3.11	**EXPLAIN** the purpose of the CIF Distributed Control System SCRAM function to include: a. Controls that initiate a scram b. Automatic functions that initiate a scram c. Actions that occur during a scram and the reason they occur

The SCRAM button provides the operator with the ability to place the plant in a safe shutdown condition during a loss of the DCS or during a control room evacuation. The SCRAM button, located below the CCTVs, de-energizes a total of 270 PLC outputs, placing the associated equipment in the fail-safe condition. Table 2 summarizes the fail-safe condition of CIF process equipment.

Likewise, watchdog timers monitor DCS functions and causes an automatic scram if it senses that the DCS is not communicating with the PLC. When this occurs, PLC outputs are de-energized as above, placing the plant in a fail-safe condition.

There are three sets of watchdog timers in the system. One set is hardwired to each MLC that has field I/O (MLC-14, 15, and 16). For each MLC, a watchdog card is installed for each of the two redundant processors. These timers sense the scan the MLCs perform every 200 milliseconds.

Normally, failure of the on-line processor will result in the redundant processor automatically taking over and controlling. If both processors failed, (e.g., a loss of power to the MLC), the watchdog timer would not sense a scan. If it does not sense a scan within 5 scans, the timers will cause a scram. When a watchdog timer causes senses the loss of communication, the green LED on the card will turn red.

If the scram occurs in this fashion, a loss of communication alarm will occur on the DCS for the affected MLC. In order to reset the alarm and scram, a small button, located on the watchdog timer card, must be pressed to reset the function. This will reset only if the condition causing the scram is corrected. Once reset, the LED will be green.

Another set of watchdog timers is connected for the foreign device interface, sensing the communication between the MLCs and the PLCs. If this watchdog timer does not sense communication for 60 seconds (indicating a problem with the MLCs, FDIs, or HLL), it will cause a scram.

Table 2 – Fail-Safe Positions Following a Scram

Fail As They Were Prior to the Scram – Will Retain Interlock Functions
Quench Pumps
Scrubber Pumps
Quench Tank Level Control
Fire Water Valves/Emergency Water Valves
Combustion Air Fans and Dampers
ID Fans and Dampers
RK Drive
Purge Fan
SWF Hydraulics
Will Turn Off
Sump Pumps
Rad Oils/Solvent Unloading Pump
Fuel Oil Unloading Pump
Fuel Oil Transfer Pump
Fuel Oil Feed Pumps
All Waste Tank Transfer Pumps
All Liquid Waste Feed Pumps
All Waste Tank Heaters
All Waste Tank Agitators
Filter Feed Pumps
Filter Transfer Pumps
Filter Concentrate Pump
Offgas Tank Agitators
All Caustic Pumps
All Blowdown Pumps
Control Room HVAC and Toilet Fan
ICR Fan
SW Conveyors
Valves that Close
All Valves Controlled by the DCS that Affect Waste or Fuel Oil to the Incinerator
All Valves Controlled by the DCS that Affect Atomizing or Purge Steam to the Incinerator
All Valves Controlled by the DCS that Isolate Propane to the Incinerator
All Valves Controlled by the DCS that Control Sump Pump Destinations
OGQ-3100 A/B
Ram Enclosure Purge Valve
Ram Feed Housing Pressure Control Valve
All Valves Controlled by the DCS that Control Offgas Blowdown or Filter Operations
Valves that Fail Open
1704 Damper
Propane Vent Valves
Other
Process Water Pumps Shift to High Speed
Ashout Knife Gate will Fail in the Position is was prior to the scram

When a scram occurs, the PLC SCRAM alarm will sound on the Rad Monitoring Panel in the control room. All discrete functions will go to their fail-safe condition as indicated in Table 2. Analog functions will go to their emergency standby condition. In this condition, the controller inputs a set value for the parameter being controlled.

After clearing the scram condition, the scram can be reset using the SCRAM reset tag, located on display 781. Each controller can be returned to its design operation with the A/M button after resetting the SCRAM. This will restore the DCS to a controlling configuration.

The third watchdog timer senses communication between the VAX and the PLCs. If communications are lost, a scram will not occur, but solid batch operations will stop.

Loss of a PLC Drop

The effects on plant operation from a loss of a PLC drop differs from a scram. Recall that during a scram, certain PLC outputs were de-energized to place the plant in a fail-safe condition. During a loss of a drop, power is interrupted to the PLC inputs in the drop, along with some power that is leaving the drop. For this reason, certain equipment will be de-energized, not just the PLC output. For example, 120 VAC power to the solenoid valves for the emergency firewater valves originates in the PLC drop. When this power is lost, power to the solenoid valves is also lost, causing the solenoid valves to close. Since the emergency firewater valves are air to close valves, this loss of air causes the valves to open with no control from the DCS. In this situation, the CRO will recognize the PLC drop loss because other equipment not controlled from that drop will work normally. Actions must be taken to control equipment locally when the drop is lost.

Interlocks and Permissives

3.12	**EXPLAIN** the terms “permissive” and “interlock” as they pertain to the operation of components from the DCS.

The DCS allows Control Room operators to monitor and react to changes within the facility. These changes may occur as problems (i.e. alarms or malfunctions) or as required operational changes to process needs (i.e. setpoint or flow rate changes). As specific functions of the facility proceed, a specific sequence of events (permissives) must be followed. A permissive may be considered to be a process-related condition that must be satisfied for the associated device to start up. This sequencing of events allows the DCS to invoke interlocks. The interlocks allow a process to proceed if all permissives have been met. After the device has started up, there is no longer an interlock. If a permissive condition has not been met, the DCS programming does not allow the process to continue. A good example of this relationship is the burner start permissive for purging the RK. The overall sequencing of CIF integrated operations is based on sequencing from each of the major areas of the facility (i.e. Ashcrete, Box Handling, Incinerator, Tank Farm, etc.).

SYSTEM INTERRELATIONS

Introduction

The MLCs and PLCs in conjunction with the BMS (Burner Management System) provide monitoring and control of the Incinerator and its support systems. All discrete I/O signals, except I/O for burner safety that is processed through the BMS, is processed through the PLC. All CIF analog I/O for instrumentation and controls is processed through MLCs.

BMS/Incinerator System

The BMS controls the initial ignition sequences of the burner igniters for the Incinerator burners for the ROW, Blended Radioactive Waste, and Fuel Oil systems as well as the Aqueous Waste nozzle. DCS provides the overall burner firing rate control after ignition as well as initiating the starting sequence of the other equipment (e.g., pumps, flow control valves), and control of the fans in the Forced Draft (FD) System during Incinerator purge. The BMS also sends equipment status information to the DCS that is used to evaluate the overall operation of the Incinerator burners.

Solid Waste Handling System (SWHS)

The SWHS is controlled and monitored by the DCS discrete I/O through the PLC. Label scanners and photoelectric eyes provide input to the VAX 4000-500 to allow tracking and assimilation of information and to provide interlocks for inspection stations as boxed waste is transported to the Incinerator. DCS controls the operation of the drive motors and conveyor box brakes to move boxes through the inspection stations and label scanning equipment in the SWHS. Labels are scanned each time a box enters an inspection station so that information can be tracked by VAX 4000-500 as boxes move along the conveyor system.

Ash Handling System

The Ash Handling System operates independently of the DCS. It is a separate, stand-alone system that can be controlled manually by the operator or controlled and monitored automatically by a PLC using an interface between the Metra Processor monitor and keyboard.

Offgas System

The Offgas System is controlled and monitored by the DCS. Instrumentation is provided which measures various process variables and provides signals back to the controllers in the DCS. The Offgas Student Study Guide offers a complete description of the DCS control features including instrument identification and setpoints values.

The DCS monitors the following equipment functions and parameters:

- SCC to quench vessel D/P
- Quench vessel to scrubber inlet D/P
- Scrubber DP, scrubber to cyclone separator D/P
- Mist eliminator D/P
- HEPA filters D/P
- Reheater D/P
- Quench recirculation line temperature
- Scrubber recirculation line temperature
- Reheater inlet temperature
- HEPA filter inlet temperature
- ID fan outlet temperature
- Vibration of ID fans
- Scrubber flow
- Quench recirculation flow
- Individual quench nozzle flows
- Kiln and cyclone separator pressures
- SAAM flows and activities
- Opacity
- CO/O_2

INTEGRATED PLANT OPERATIONS

Principles of Operation

EO 4.01	Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following: a. Controlling equipment from the DCS b. Making routine DCS configuration changes

The DCS provides the operator controls for the CIF. The system controls the operation of electric motors and remote controlled valves within the facility. The equipment is normally operated in an automatic mode. However, the system provides the operator with the ability to control components on an individual basis. The control room operator can close or open a valve and start or stop an electric motor (for a fan, pump, etc.).

The ICR Operator Stations provide a window to the processes within the CIF. The consoles also provide a method for the facility engineer to configure controls, graphics, and other functions. The two modes of process control and configuration are distinct. They are separated by means of a key switch that enables the configuration mode.

The ICR Operator Stations provide mimic displays for each of the CIF systems. The displays include the component identifiers and show the current values for temperature, flow, level, and pressure provided by field instrumentation. Dynamic equipment such as valves, pumps, or fans will be displayed in either green or red, depending upon its status. For example, equipment will be highlighted in green if it is currently on, energized, running, open, moving, extended, tilted, or not in alarm. Equipment will be highlighted in red if it is currently off, de-energized, not running, not moving, retracted, untilted, or in alarm. Valves that have a variable position capability and only have a demand signal will always be displayed half-green and half-red with the demand position (in percent open) listed under the valve.

The process graphics displays are interactive and provide real time observations of equipment status and operating parameters. The screens are presented in varying degrees of detail. The more detailed graphics screen allows for control of selected equipment and operator controlled variables. The screens will generally be in a layout with that screen's main process lines highlighted in green and major support lines highlighted in light blue.

Other auxiliary lines will be highlighted in purple. Major static components will be highlighted in yellow. Thick and thin lines are further used to distinguish between major and sub-flow paths.

Area displays provide an overall view of the alarm status and the organization of tags in a given area. The groups are presented in a combination of digital and graphic format. As a minimum, Input, Output, and Setpoint or Target will be shown in the graphic portion of the display. The faceplate portion of the display contains the equipment identifier, equipment service description, engineering units (i.e., pressure, flow, temperature), input signal, output (in percent), setpoint, setpoint status (local or remote), and the control status (manual or automatic). By selecting the proper loop, the operator is able to manipulate the Control mode (auto or manual), Setpoints, and Output for the loop (if control mode is manual).

The ICR Operator Station keyboard provides the operator with access to DCS and PLC controls for the process. The operator may perform the following functions:

- Select and initiate discrete control functions such as start and stop motors, open or close valves, start process sequences and steps (such as the Incinerator purge cycle)
- Select analog control functions to change setpoint, select the operational mode of control loops, perform control loop tuning, ramping, and changing alarm points
- Initiate DCS functions such as selecting displays, acknowledging alarms, printing reports, and entering data

By pushing the Alarm List button, alarms are displayed in chronological order in a table format with the most current alarm appearing at the top of the display page. The alarm-paging feature retains alarms in an alarm summary of at least 1,000 alarms.

An acknowledged process variable alarm that returns to normal condition is erased from the alarm display. The alarm status (new or acknowledged) is identified by an audible signal, flashing display, and color changes.

The VAX Data Archival System stores information or process parameters and the inventory of radioactive isotopes processed at the CIF. The operator can select any process parameter for trending. The trend data can be viewed at the ICR Operator's Station.

Initial Configuration

Prerequisites for DCS startup include available power to the DCS components, an approved/configured MLC database, and knowledge of systems that will be on or off line (alarm acknowledgment).

Power for the DCS is established by performance of the following Standard Operating Procedures: 261-SOP-ELNA-01, 13.8 KV/480 Volt Substation Electrical, which aligns the 480 VAC Substation; 261-SOP-ELNH-01, 480 Volt Power Electrical; which aligns the 480 VAC MCCs; and 261-SOP-UPS-01, Uninterruptible Power Supply and Instrument Power Operation, which aligns the 208/120 VAC Instrument Power Panels to the UPS and places the system in service.

Before any CIF system can be monitored or manipulated by the DCS, it is necessary to establish power and align manually operated valves associated with the specific system. This is accomplished by performing Standard Operating Procedures (SOPs) for that particular system (which will ensure completion of required breaker alignment checklists and valve alignment checklists).

System Startup

The following steps detail placing an operator station on-line.

- Turn station power on. In stations with a MYCRO console enclosure, the on/off switch is located on either a power distribution box on the cabinet floor or on a multiple outlet power strip that may be mounted in one of several locations.
- The Main Menu will be displayed with GO ON-LINE highlighted. SELECT is pressed in the CURSOR CONTROL section of operator's keyboard. The following list will be displayed.

GET DATA BASE FROM:

1. HARD DISK

2. CARTRIDGE

3. EXIT CCS

ENTER NUMBER ...1

- Type 1, for hard disk, and press the ENTER key in the NUMERIC ENTRY section. A listing of databases by name and description will be on the screen. For example:

USE DATA BASE NAME:

1. INCINERATOR FUEL OIL BURNER

2. SOLID WASTE FEED SYSTEM

3. EXIT CCS

ENTER NUMBER ...1

- Make a selection and press the ENTER key. Unless Console Security is enabled (see next button), the station will go on-line and display the lowest numbered configured operator display.

Normal Operations

Normal operations consist of CIF operators monitoring the DCS, responding to alarms, resolving malfunctions, and making required changes to process parameters. Operations personnel will complete routine checks of equipment utilizing roundsheets.

System Shutdown

During shutdown of the facility, the DCS will remain ON. Depending on the extent of the facility shutdown, a set of specific alarms and items will be continually monitored.

1. To go off line, keylocks are placed in “CONFIGURATION” and “CONTROL.”
2. The “POINT” key is pressed and “OFF LINE” (two words) is typed. The ENTER key is pressed.
3. The prompt will ask if the Trend Index is to be saved. Yes or no is entered.
4. The prompt will ask if the database is to be saved. Yes or no is entered. In most cases, “NO” is entered, but supervision should be consulted.
5. If the power is to be turned off, the cursor is moved down on the main menu to “PREPARE FOR SYSTEM RESET/POWER DOWN” and the select button is pressed. The prompt will indicate “SYSTEM MAY NOW BE RESET.”

DCS Troubleshooting

During operation, a pump or valve will fail to respond to DCS commands. Sometimes this occurs due to a permissive not being met and sometime it occurs due to field problem, such as a blown control power fuse or tripped overload relay. Troubleshooting these symptoms can correct the problem for continued operation.

To understand how to determine system problems, the normal operation for a typical component must be understood. When a pump is started, the operator will press the D1 key on the DCS. This closes an electronic contact within the PLC. If permissives are met, the PLC will send a signal to the pump’s motor controller causing the motor starter contactor to close and start the pump. The closing of the motor starter contactor is also sent back to the PLC, and a green run indication is fed to the DCS. If the PLC does not sense that the pump is running, it will stop the pump by reopening the circuit to the motor starter contactor.

If the pump failed to start because of a failure of the hardware (e.g., blown fuse, tripped overload, etc.), then the indication on the DCS will be a red blinking stopped indication. This means that the PLC was satisfied by the permissives necessary, but that the pump failed to run. At this point, E&I would be called to investigate the problem.

If the pump failed to start because a PLC permissive was not met, a steady red stopped indication will be observed on the DCS. At this point, the operator must determine what permissive was not met in order to correct the situation.

The engineering workstation (EWS) is loaded with a Taylor software program that allows the operator to visually observe the logic associated with the operation of equipment. In addition, it provides capabilities for the DCS Engineer to change the software associated with the CIF DCS. At the EWS, the associated point tag can be searched to determine which coil is associated with the equipment that failed to start.

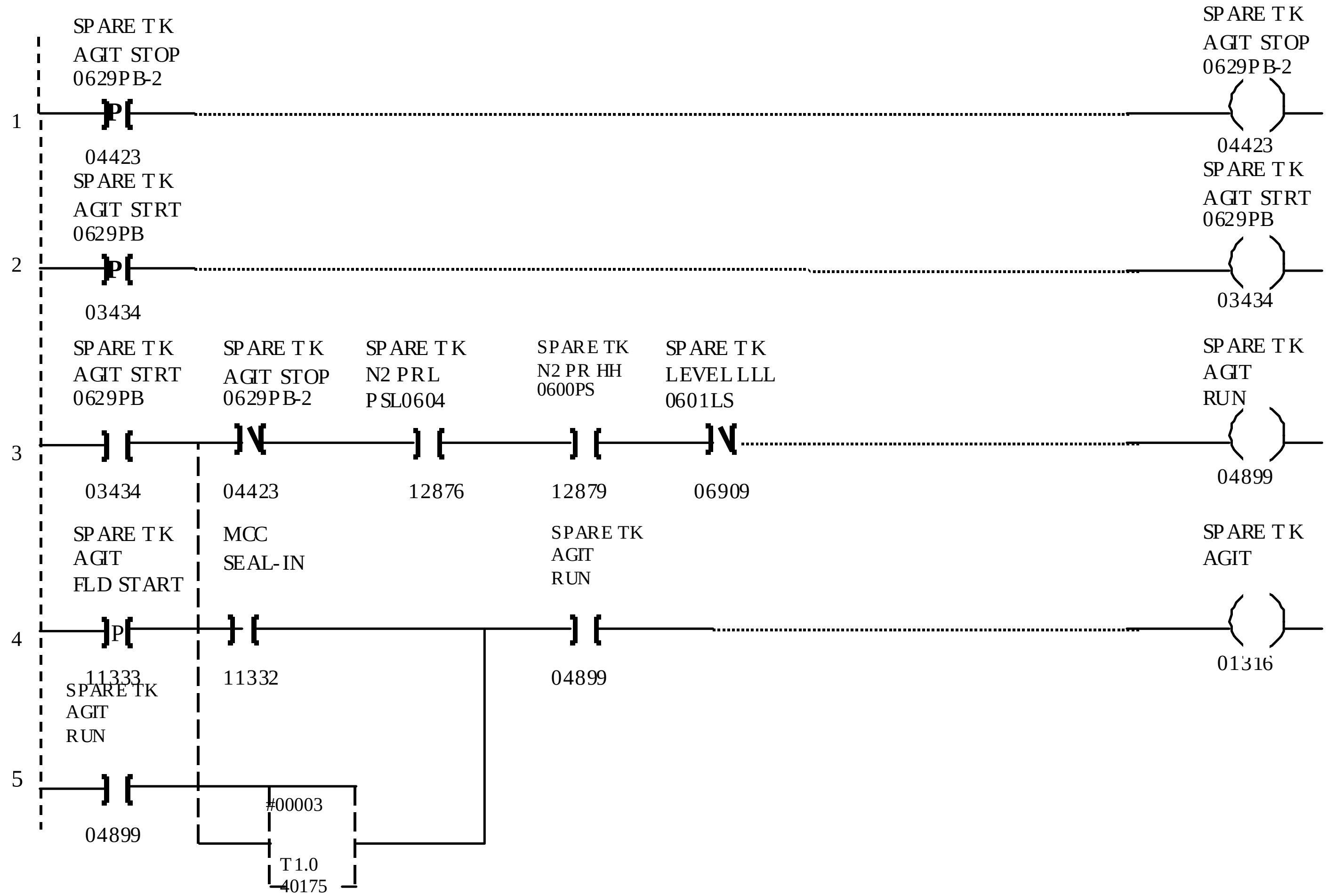
A coil in the PLC logic diagrams can be thought of as a software version of a relay (Figure 15). Like a relay, a coil can have a number of contacts that are normally open or normally closed. The Taylor database can graphically display this logic in what is known as ladder logic diagrams. Within the database, curved lines and a coil number represent coils. The associated contacts for the coil may be normally closed if a slash exists through the contact, or normally open with no slash.

If the contact or coil has a number starting with a 0, then it is an output from the PLC. If the contact or coil has a number starting with a 1, then it is an input to the PLC. Additionally, if a coil is a direct connection to a field device, then the coil number will be within the following ranges:

- Process PLC – ≤02961
- Ashcrete PLC – ≤00064
- Ashout PLC – ≤00056

Any coil number greater than these numbers is an internally generated signal from the DCS, Metra, or PLC. Examples of these types of coils would be starting signals from the console, DCS flashing indications, and alarm signals that actuate interlocks and permissives.

Network 0229 Segment 07



Legend: First Digit: 0 - Output from PLC
1 - Input to PLC

Last Four Digits: < 2960 - Indicates a direct field contact
> 2960 - Indicates an internal contact (e.g.., DCS generated signal)

Contacts/Coils:] [- De-energized Open Contact
]\[- De-energized Closed Contact
( ) - Coil

Figure 15 – Process PLC Ladder Logic Diagram

Figure 15 shows a typical ladder logic diagram found in the process Taylor database (network 0229 for the spare tank agitator). As shown on the diagram, the following conditions must be met in order to start the spare tank agitator:

- A start signal must be sent from the DCS (coil 3434) or from the field (11333)
- A stop signal cannot be present (coil 04423)
- Spare tank nitrogen pressure cannot be low (coil 12879) or high-high (coil 12879)
- Spare tank level cannot be low-low-low (coil 06909)

If these conditions are met, then coil 04899 will energize, contact 04899 will close, and the spare tank agitator will start by energizing coil 01316 through timer 40175. The timer will allow current flow for 3 seconds while waiting for a signal from the MCC that the motor has started (MCC Seal-in, contact 11332). If the seal-in signal is not received, the agitator coil will be de-energized.

Figure 16 shows a typical ladder logic diagram found in the ashcrete Taylor database (network 0073 for the drum lift drive). As shown on the diagram, the following conditions must be met in order to start to lift the drum:

- A lift signal must be sent from the Metra (for cap removal or replacement, water fill, cement fill, tumbling, or manually)
- A car forward or reverse signal cannot be present (00017 and 00018)
- The door must be closed and cannot be open (10007 and 10008)
- The Metra cannot be paused (coil 00385)

If these conditions are met, then power will be applied through the timer. The timer will allow a pause for 3 seconds to allow the drum to stabilize. After three seconds, coil 00021 will energize, activating the drive in the up direction.

These are just two examples of the logic available in the database. When entering the database, a search can be made on the component to determine what coils are associated with the component. Once the coil is determined, the Taylor program will graphically display the continuity of each operating logic so that the permissive that was not met can be determined. Once determined, the situation can be corrected and the operation resumed.

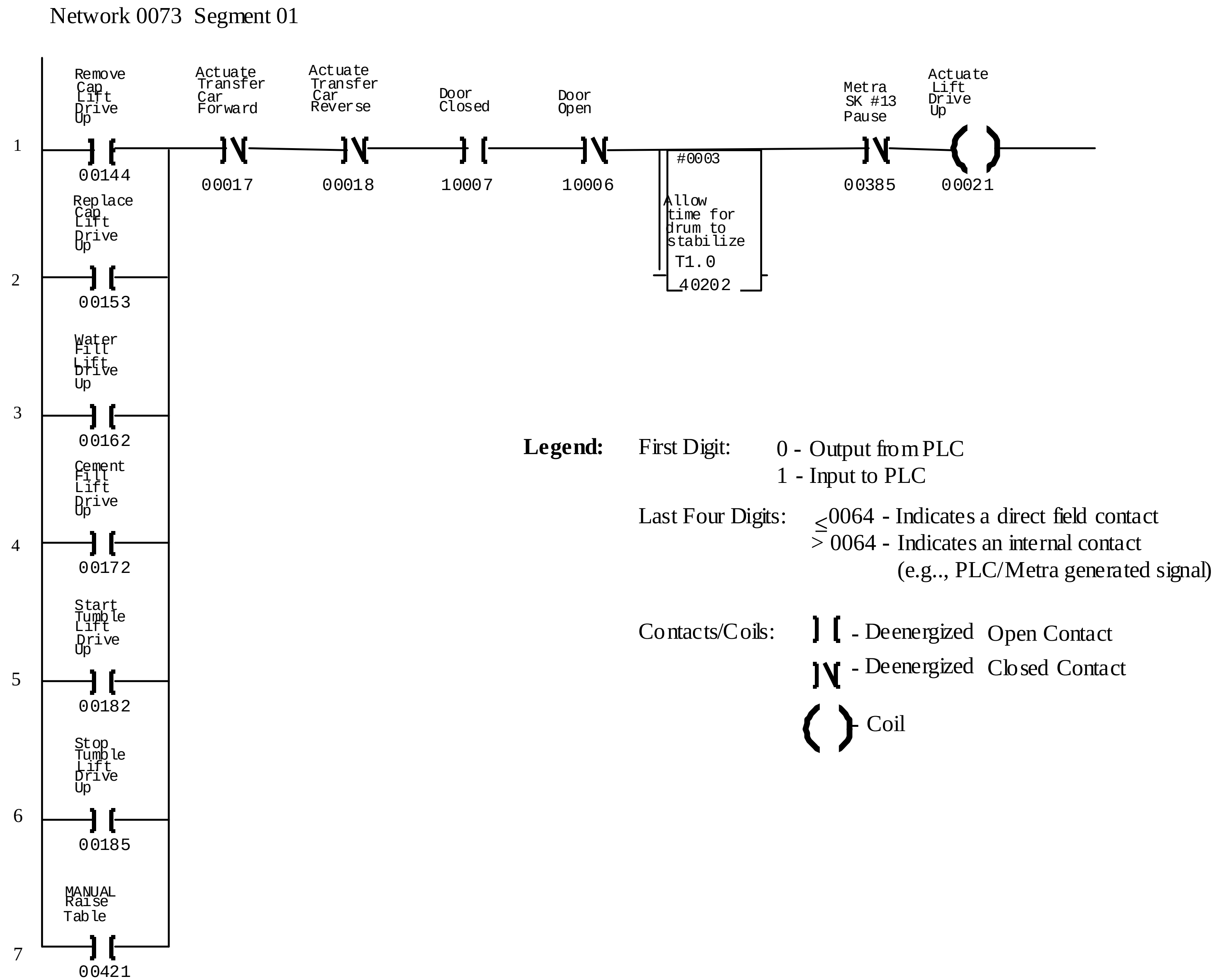


Figure 16 – Ashcrete PLC Ladder Logic Diagram

Forcing Coils

EO 4.02	**EXPLAIN** the process of forcing a coil on the DCS, to include: a. What is meant by forcing a coil b. Hazards associated with forcing a coil c. When a coil is allowed to be forced

During some procedures and due to plant modifications, it is sometimes necessary to "force" coils. Forcing a coil is nothing more than disabling the coil from the logic and forcing it to change state, either ON or OFF. This is usually necessary in order to perform non-routine evolutions, like special procedures and testing.

Forcing coils cannot be taken lightly. There are inherent hazards in forcing coils, and these must be understood in order to ensure the system operates correctly. The following are typical problems that can occur due to forcing coils:

Bypassing Permissives and Interlocks

Whenever a coil is forced, any interlocks or permissives associated with that coil is bypassed, because the coil is manually being placed in a condition. For this reason, any interlocks that should be in place must be verified to either be satisfied by procedure conditions or be permissible to bypass. Some interlocks are associated with permit and process requirements so these documents must be verified to allow the condition.

Reprogramming of PLC Logic

Whenever the EWS is used to force a coil, the Taylor software must be in the "PROGRAM" mode. In this mode, any changes to the logic will actually reprogram the PLC logic. Any inadvertent changes to the system can disable interlocks, permissives, or operability of equipment.

In addition to the disabling of logic, changes in the program will be inserted into the on-line PLC and not to the standby PLC. If the on-line PLC fails, the standby PLC will sense that the programming is different and will not automatically shift on line. This can result in a loss of the DCS.

Inadvertent Equipment Operation

If the wrong coil is forced, or if the procedure or modification has not taken into account current plant conditions, then forcing a coil may cause equipment to start or stop inadvertently. For this reason, any person forcing a coil must use the Taylor database and search for all networks that contain the coil or the associated contacts. Each network must be checked in order to ensure that the forcing of the coil will not adversely affect other equipment.

Forcing Internal Coils

Internal coils are coils that are generated through PLC programming, and are similar to relays in electrical terms. An example of an auxiliary coil would be the coils that cause a green running indication on the DCS. These coils have numbers greater than 2960, and always are preceded by a 0.

If the coil is in the range of 06784 to 06801, these internal coils are generated by the DCS using analog indications and are sent to the PLC via the FDI to activate interlocks. These coils cannot be disabled and forced because the DCS overwrites the manual force condition every 500 milliseconds. For these conditions, the alarm must be disabled in the DCS (not out of service) to disable the interlock.

Using the example in Figure 15, the spare tank LLL level alarm interlocks the agitator off. If it were necessary to bypass this interlock, the LLL level alarm would be selected on analog point page 2 and disabled. This would prevent the agitator from stopping if the alarm were received.

For these reasons, strict controls are placed on forcing coils. Coils may only be forced during the following conditions:

- As specified by procedures. These may be operating procedures, maintenance procedures, or special procedures.
- As directed by plant temporary modifications
- As approved through design modifications

In addition to the above requirements, the Shift Manager must be cognizant of and approve all changes to the DCS logic.

DCS Alarm Operations

When an alarm point alarms, the DCS automatically sounds an audible alarm and prints out an alarm message to the printer and to the Data Historian. Pressing the SILENCE button on the operator console will silence the alarm.

The operator will then identify the alarm. If no other alarms were acknowledged prior to the actuation of the alarm, the operator needs only press the PRI ALARM key on his/her console. Pressing this button brings up the faceplate/graphic that is in alarm.

The alarming faceplate should be flashing red or yellow. A flashing red alarm means that the operator is required to take corrective action after acknowledgment to prevent equipment damage. A flashing white faceplate indicates that the alarm is out of alarm state, but has not been acknowledged (e.g. a Control Room Operator responds to a HIGH-HIGH Tank Level by starting a pump to lower the tank level, the level is subsequently pumped below the HIGH-HIGH Tank Level setpoint to exit the alarm state, but the operator fails to acknowledge the alarm). This indication that the tank level has gone below the HIGH-HIGH Tank Level setpoint and out of the alarm state is referred to as "ring back". The actions that an operator takes at the DCS console upon the actuation of alarms are determined by the approved Alarm Response Procedures.

First Out Alarm Capability

When a trip occurs on the fuel oil burners or liquid waste streams, numerous alarms occur almost simultaneously. The first alarm is the cause of the trip, and the following alarms are because of the trip. This can be confusing to the Control Room Operator due to the shear volume of alarms received.

First out capability is part of the alarm reduction program. What first out does is to allow the alarm causing the trip to annunciate, but masks subsequent associated alarms. This provides a means for the CRO to quickly identify the reason for the trip and mitigate those circumstances, without having to first determine the cause.

Loss of the DCS

EO 4.03	Given applicable procedures and plant conditions, **DETERMINE** the effects on the DCS and the operator's response during a full or partial loss of the DCS.

The DCS conducts continuous self-diagnostics and indicates malfunctions or communications failures as an audible alarm. The failure of a redundant controller, power supply, or other redundant feature results in an alarm. Total communications failure between the PLC and the MLC could occur as a result of total failure of any of the following: Redundant Data Highways; or Redundant Foreign Device Interface (FDI). Possible alarms received on DCS Consoles to indicate a loss communications for the MLCs include:

- MLC14 Loss Comm Status on Point Tag MLC14-ALARM, MLC14 Alarm
- MLC15 Loss Comm Status on Point Tag MLC15-ALARM, MLC15 Alarm
- MLC16 Loss Comm Status on Point Tag MLC16-ALARM, MLC16 Alarm

During this event, an alarm is received on the Rad Monitoring Panel for "PLC SCRAM." Operators will take actions to place the facility in a safe condition. This includes ensuring that vital equipment is operating to support a safe shutdown of the facility. The PLC shutdown reset will be actuated on display 781 to regain control of the affected equipment from the DCS.

PLC Cabinet High Temperature Alarms

Each of the PLC cabinets located in the IER is provided with a temperature switch and corresponding alarm. The setpoint for temperature switches H-261-DCS-TSH-6500 (Cabinet #1) and H-261-DCS-TSH-6501 (Cabinet #2) is set at 130°F. Possible alarms received on DCS Point Tag Display FDAS6500TA-1, PLC CONTROL CAB TEMP ALM, to indicate a high temperature in the PLC cabinets include:

- 6500TA HIGH TEMP PLC CAB #1
- 6501TA HIGH TEMP PLC CAB #2

The actions which an operator takes at the DCS console upon the actuation of any of the above listed alarms is determined by Alarm Response Procedures 261-ARP-FDAS6500TA, HIGH TEMP PLC CAB #1; or, 261-ARP-FDAS6501TA, HIGH TEMP PLC CAB #2.

I/O Drop Cabinets Loss of Power

Sensing from the drop cabinets is via the HLL. In the event of a loss of power at one of the cabinets, the operator may receive numerous alarms related to components supplied from that cabinet. The alarms will print out on the line printer before the operator may have time to scroll across the DCS screens and recognize the cause of the problem. Another aspect associated with this type of event is that all outputs from the cabinet will go open; all motors will stop and valves go to the fail-safe position. Critical motors will have to be restarted in the local manual mode. Other actions will need to be taken to place the facility in a safe condition, such as closing the emergency fire water valves. Due to the location of the watchdog timers, a loss of power to the I/O drop cabinets will not cause a scram alarm.

APPENDIX A

CONSOLE MANIPULATIONS

Point Pages

Three point page displays contain detailed information about a point. From these pages an operator may: view real-time plots of selected variables; initiate control and value adjustments; make configuration changes; tune controllers; and silence and acknowledge alarms.

Point Page 1 is used on-line and contains a real-time plot of analog point variables or discrete point input channels. This page is also used with analog points when tuning controllers.

During off-line configuration, Point pages 2 and 3 are used to specify and enter all required information for on-line operation of a point. On-line, Point pages 2 and 3 are used primarily as references and to make limited configuration changes.

Point pages can be called for display by selection from an operator display or by pressing the POINT key on the keyboard.

Call a Point for Display

- The keylocks are placed in OPERATE/MONITOR or OPERATE/CONTROL.
- The POINT key is pressed.

PROMPT: ENTER POINT TAG (MAX 12 CHARS):

- The point tag is entered (e.g. WTE0400L-1) and ENTER pressed.

The PAGE keys and the LAST key in the DISPLAY SELECT section can be used to move between point pages. The "<" and ">" PAGE keys select lower and higher numbered pages, respectively, and the LAST key selects the previously displayed page.

Each point page has common information displayed at the top:

- POINT PAGE NUMBER   POINT TAG
- ALARM IN DISPLAY NUMBER   POINT NAME
- DATE CRT NUMBER
- TIME TOTAL AND UNACKNOWLEDGED ALARMS

Note that the point tag is also used to indicate the status of alarms configured for a point. The tag may blink, change foreground and background colors, or remain steady depending upon the alarm condition.

Operator Displays

Operator displays are user-configured graphics that are created to represent the process. They are constructed off-line using preformatted blocks, symbols, and characters. From these displays, the operator can view active process data and interact with the process for control purposes. The maximum number of displays that can be configured for one database is 999.

All blocks, except display blocks, are dynamic; symbols can be dynamic or static; and characters are always static. A dynamic block or symbol has a point assigned to it for control purposes.

Highlighting and selecting a dynamic block or symbol allows an operator to access the assigned point to view point information, make control adjustments, and acknowledge alarms.

Hierarchy

The hierarchy of operator displays is determined off-line during configuration. The Operator Display Hierarchy List defines which displays will be called with one keystroke when pressing the PLANT, AREA, GROUP, GRAPHIC, LEFT, RIGHT, and UP keys in the DISPLAY SELECT section of the keyboard.

Call Hierarchy List

- MENU is pressed.
- “Operator Display Hierarchy List” is highlighted and SELECT pressed.

PROMPT: ENTER PAGE NUMBER (1-26) OR <ENTER> FOR PAGE 1

- The page number is typed in and ENTER pressed.
- Once a page is displayed, an operator can also use "<" and ">" PAGE keys to move between the 11 pages of listings.

Store and Recall

The STORE and RECALL keys in the DISPLAY SELECT section are used to store and recall up to 10 displays. Any display can be stored for recall.

Store Display

- DISPLAY is pressed.

PROMPT: SELECT OPERATOR DISPLAY (1-999):

- The number of display to be stored is entered and ENTER pressed. The display will appear on screen.
- STORE is pressed.

PROMPT: ENTER SCREEN NUMBER (1-10):

- The screen number is entered and ENTER pressed.

Recall Display

- RECALL is pressed.

PROMPT: ENTER SCREEN NUMBER (1-10):

- A screen number is entered and ENTER pressed. The display will appear on the screen.

Alarms

Each point in a database can have up to four alarms configured. These alarms are configured off-line on point page 2. The following subsections discuss alarms pertaining to on-line operation of point pages and operator displays.

Indications

For alarm messages and faceplate indication, foreground and background colors are assigned off-line to each configured alarm type. Once these colors are assigned they will be standard for that type of alarm for every point in the database. Foreground and background colors can be changed on-line on the System Configuration Page with the CONFIG key active.

When a point goes into alarm, the point tag will flash on and off in the configured colors of the highest priority alarm at that point. The point tag will flash on point pages and operator displays and in blocks located on operator displays. Table 3 shows the point tag indications for the various alarm states.

Table 3 – Point Tag Indications for Alarm States

STATE	TAG	Foreground/Background COLORS
NO ALARM	STEADY	BLACK/BLACK
UNACKNOWLEDGED	FLASHES	AS ASSIGNED TO ALARM TYPE
RINGBACK	FLASHES	BLACK/WHITE
ACKNOWLEDGED	STEADY	SAME AS UNACKNOWLEDGED
OUT OF SERVICE	STEADY	WHITE/BLUE

Blocks (except process) located on operator displays which do not indicate the assigned point tag, but display point information, provide the same color indications within the block as do point tags. Note that with "single value" blocks and "single value without border" blocks, alarm indication must be selected by answering a prompt during off-line configuration.

When a point goes into alarm, an audible beeper on the keyboard sounds and a configured line printer will automatically log the event. Also, if alarm contacts located in the base of the cabinet have been enabled, their respective circuits will provide alarm indication.

Silencing and Acknowledging

The audible beeper can be silenced by pressing the SILENCE key in the ALARMS section of the keyboard or by acknowledging all points in alarm. Points in alarm can be acknowledged from a point page or operator display.

Acknowledge an Alarm on a Point Page

1. The point is called.
2. The ACKNOWLEDGE key in the ALARMS section is pressed with any of the three point pages on the screen.

Acknowledge an Alarm on an Operator Display

1. A block or dynamic symbol to which the point has been assigned is highlighted.
2. The ACKNOWLEDGE key is pressed.

Priority Alarm

The PRIORITY ALARM key in the keyboard's ALARMS section allows calling up displays with critical points in alarm by using only one keystroke. Press this key to call the UP display of the point with the highest priority unacknowledged alarm.

Lists

The following subsections discuss the various alarm lists. These lists are accessed by pressing their respective keys in the keyboard's ALARMS section.

Access an Alarm List

1. The applicable list key is pressed.

   PROMPT: ENTER PAGE NUMBER (1-26) or <enter> FOR PAGE 1

2. The page number is typed in and ENTER pressed.
3. The PAGE keys can be used to move between pages.

Priority

The Priority List contains current, unacknowledged alarms according to their priority, 1 through 4.

Priority 1 is the highest priority and priority 4 is the lowest priority. Priorities for alarms are assigned off-line during point configuration. If more than one alarm has the same priority, entries into the list will be made with the last alarms on the top of the page. Within the same point, alarms will be listed in order of alarm bit priority. The alarm priority, point tag, and alarm message are entered for each alarm. This list will show only active alarms for the current operating mode.

Time

The Time List contains current, unacknowledged alarms in "last in, first out" order (LIFO) with the most current at the top of the list and the oldest at the bottom. The alarm priority, point tag, and alarm message are entered for each alarm. The list will show only those events that occur in the current alarm mode.

History

The History List contains alarm events with the most recent event at the top of the list and the oldest event at the bottom. Alarm events entered are listed in the Alarm Events column as follows.

ALARM	When an alarm is triggered
CLEAR	When an alarm is cleared (point is no longer in alarm)
ACKN	When a point is acknowledged. A point can be acknowledged when in alarm, or after it comes out of alarm in case of ringback.
IN SERV	When alarms for a point are put into service
OOS	When alarms for a point are taken out of service
ENABLE	When an alarm is enabled
DISABLE	When an alarm is disabled

The list will show only those events that occur in the current alarm mode. The date, time, point tag, alarm descriptor (message), alarm event, and display number are entered for each event.

Summary

The Summary List provides indication of operator displays that have one or more points in alarm. Table 4 shows the information as follows.

Table 4 – Summary List Alarm States and Indications

ALARM STATE	**DISPLAY # FIELD**	**DISPLAY # Foreground/Background COLORS**
NO ALARM	BLANK	BLANK
UNACKNOWLEDGED	FLASHES	WHITE/BLACK
RINGBACK	FLASHES	BLACK/WHITE
ACKNOWLEDGED	STEADY	WHITE/BLACK

Out List

The Out List contains all points that have alarms out of service or disabled. The point tag, type (analog or discrete), descriptor (name), Up Display number, Alarm 1, Alarm 2, Alarm 3, and Alarm 4 are entered. If any alarm 1 - 4 is disabled, it is indicated by a block indicating green “disabled.” Alarms enabled are indicated by a green block indicating “enabled.”

APPENDIX B - KEYBOARD FUNCTIONS AVAILABLE

Table 5 – Operator Privileges in Control Modes

MONITOR MODE	**CONTROL MODE**	
ALL PRIVILEGE LEVELS	**SPECIFIC PRIVILEGE LEVEL***	**KEYBOARD FUNCTIONS AVAILABLE TO OPERATOR***
Change Displays Change Monitors Silence Alarms	Operate	Use Control and Value Adjust Keys Silence and acknowledge alarms Change alarm modes (if desired) Manipulate first three tuning parameters (Plot, R Time, R TGT) Manipulate trend plot data Make temporary changes to Trend Display configurations Initiate function key sequences
	Tune	All functions under "Operate" Change all tuning parameters Change all alarm settings Place alarms in or out of service Change alarm modes
	Configure	All functions under "Operate" Trend Rate Change controller action Assign points to trend configuration Change mode key masking Manipulate colors and descriptors Change alarm messages Change 0% and 100% values Make changes to System Configuration Page (alarm contacts, alarm modes, printer assignments, set date and time) Permanently change Trend Display configuration Change satellite status's Configure function keys
	* When console security is enabled, keyboard functions associated with a given keylock position are available to operators only if authorized by the system administrator.	